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REPORT
OF THE
DRAINAGE COMMITTEE, BENGAL.

PRESIDENCY DIVISION.

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REPORT

OF THE

DRAINAGE COMMITTEE,

BENGAL.

(*PRESIDENCY DIVISION.*)

Calcutta:
THE BENGAL SECRETARIAT PRESS.
1907.

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22. MAR. 1909

No. 45.

From H. WHEELER, Esq., i.c.s.,
Secretary to the Drainage Committee, Bengal,

To the SECRETARY to the GOVERNMENT of BENGAL,
Municipal (Medical) Department.

Dated Calcutta, the 6th April 1907.

Sir,

With reference to the Resolution of the Government of Bengal, No. 1379Medl., dated the 26th March 1906, appointing a Committee to enquire into the drainage conditions of the Presidency Division and their connection with the prevalence of malaria, I am directed to submit the following report.

I have the honour to be,
Sir,
Your most obedient servant,
H. WHEELER,
Secretary to the Drainage Committee, Bengal.

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REPORT

OF THE

DRAINAGE COMMITTEE, BENGAL.

CHAPTER I.

INTRODUCTORY.

Scope of enquiry.

THE present Committee was appointed under the orders of the Government of Bengal, contained in its Resolution No. 1379Medl., dated the 26th March 1906, as the outcome of a suggestion that the time was opportune for an enquiry into the cause of the malarial fevers prevalent in Bengal and the possibility of undertaking remedial measures. It was decided, however, by the Local Government that little advantage was to be anticipated from an investigation of so wide a scope through the medium of a Committee. Knowledge of the etiology of malaria has made considerable progress in modern times, and its further extension is to be looked for rather from the continuous researches of specialists. Nevertheless, having regard to the fact that the obstruction of drainage had usually been held to be a factor in the causation of the disease in Bengal, it was considered that an advance might be made in the execution of practicable drainage schemes by an examination of the conditions of the Presidency Division, in which it was understood that the gradual changes in the many channels of the Ganges delta had prejudicially affected extensive areas. The instructions given to the Committee were accordingly fourfold, namely:—

(1) to ascertain in which areas malaria is now prevalent;
(2) to investigate the causes of the disease, and in particular to determine whether it is due to obstructed drainage;
(3) where malaria has been caused by obstructed drainage to decide whether a drainage scheme is practicable; and
(4) to prepare a list of practicable drainage schemes in the Presidency Division arranged in the order of their urgency.

Method of enquiry.

2. The Committee first assembled in November 1906, and its enquiries have continued during the cold weather of 1906-07. The place of Captain Clemesha, I.M.S., who was originally nominated, was taken by Lieutenant-Colonel Clarkson, I.M.S. Owing to the fact that it was not found possible to spare the services of the Hon'ble Mr. Inglis and Lieutenant-Colonel Clarkson for this duty solely, the undertaking by the Committee of a continuous tour was impracticable. Accordingly, after visits at the outset to the head-quarters of the different districts concerned, during which the questions at issue were discussed with the local officers and leading non-official gentlemen, and the conditions of the Sadar stations were inspected, we proceeded at different times to the most typical localities in which this preliminary enquiry indicated that the drainage was obstructed or defective, namely, the subdivisions of Jhenida, Magura and Narail in the Jessore district, of Satkhira and Bagerhat in Khulna, and of Baraset in the 24-Parganas; while journeys were also made to the heads of the Matabhanga and Gorai rivers, to the former off-take from the Matabhanga river of the river Bhairab, to Porada (Nadia) and Halishahar (24-Parganas) in order to view the state of the Bhural and Baghar khals, to Diamond Harbour, traversing the area of the Magrahat drainage scheme, and to the tract affected by the Bagjola project in the vicinity of Calcutta. By the courtesy of the Commissioner and the District Officers of the division, we have been favoured with reports as to the peculiar circumstances of each district concerned, together with expressions of the opinions of the District Boards and Municipalities affected, and with reference

particularly to the conditions of the riparian tract on the east bank of the Hooghly, north of Calcutta, we have had the advantage of hearing the views of Colonel Gupta, I.M.S. Anything in the nature of a complete drainage survey of the Presidency Division was impossible within the time, and with the means at our disposal, and, as will be shown later, the facts already on record as to the physical features of particular rivers and tracts are insufficient to permit of the preparation at present of a full programme of the schemes which it may be desirable to undertake. To this extent, therefore, we have been unable to comply with the reference to us, but an attempt has been made to present the facts which are now available, to indicate the lines of future useful enquiry, and to examine the projects which have already been so far elaborated as to permit of a recommendation as to their merits.

3. More detailed enquiries were conducted by Captain Stewart, I.M.S., and Lieutenant Proctor, I.M.S., whose services were placed at our disposal by the Government of India; but in their case also the area of investigation was more extensive than could be adequately covered in the course of one cold weather. Their local researches extended over a period of about five months (18th October 1906 to the 15th March 1907), and were directed generally towards ascertaining the extent to which malarial fever is prevalent in the districts visited, the villages most severely affected, and the local conditions determining the intensity of the disease. While their attention was directed mainly to Jessore, to which statistics pointed as the most malarious district in the division, and in which they worked for about two months, about a fortnight was spent in Nadia, and about a month in Murshidabad, in the examination of the areas bearing the worst local reputations for malaria. The final conclusions of these officers were submitted in a report, dated the 15th March 1907, which, together with their *interim* notes on the individual districts dealt with, is annexed as Appendix I herewith.

Comparison between the mortality from "fever" in the different divisions of the province.

4. While our investigation has been confined to the circumstances of the Presidency Division, and while it is the case that that division is probably the most malarious in the present province, and constitutes the area in which the factor of defective drainage is most apparent, it is not without interest to note the following statistics of recent years comparing the mortality due to "fever" in the six divisions of Bengal:—

NAME OF DIVISION.	Ratio per mille of mortality from fever. 1905.	Ratio per mille of mortality from fever. 1900—1904 (mean).
Presidency	26·3	24·5
Burdwan	22·6	20·5
Patna	25·9	21·5
Bhagalpur	29·3	23·9
Orissa	11·8	12·9
Chota Nagpur	20·6	16·7
Whole Province	24·3	21·1

It is noticeable that the Bhagalpur Division suffers from "fever" to an extent approximating closely to the conditions in the Presidency Division, while, apart from the Divisions of Orissa and Chota Nagpur, the figures for the remainder for five years do not differ widely.

CHAPTER II.

THE MALARIOUS AREAS IN THE PRESIDENCY DIVISION.

Area and physical features of the Presidency Division.

5. The Presidency Division (excluding Calcutta) covers an area of some 17½ thousand square miles (of which about 5½ thousand are within the Sundarbans), and contains a population of about 8 million people. Details regarding the different component districts are given below:—

DISTRICT.	Area in square miles.	Population (1901 census).
Jessore	2,925	1,813,155
Nadia	2,793	1,667,491
Murshidabad	2,143	1,333,184
24-Parganas	4,844*	2,078,359
Khulna	4,765†	1,253,043
Total Presidency Division ...	17,470	8,145,232

* Of which 2,941 square miles are comprised in the Sundarbans.
† Of which 2,688 ditto ditto.

With the exception of the portion of the Murshidabad district to the west of the Bhagirathi river, which is a continuation of the Chota Nagpur plateau, the division falls within the limits of the Gangetic delta. While the general conditions are those which must obtain in all deltas, namely, that the country is flat, little raised above flood level, and the highest ground is that upon the margins of the river channels, it is necessary to distinguish between the tracts in which the elevation of the land by the deposit of the silt carried in suspension in the flood water is still in progress, and those in which the operations of nature in this respect have been suspended for the time being. In the former category we find the Murshidabad district to the east of the Bhagirathi, the whole of the Nadia district, a small portion of the Jessore district to the north and east, part of the Khulna district, and a small area in the 24-Parganas along the river Ichamatti. The effluents of the Ganges, known generally as the Nadia rivers, comprising the Bhagirathi, the Bhairab-Jalangi and the Mathabhanga, convey during the flood season a large volume of water to their estuary, the Hooghly, and in years of high flood they inundate extensive areas of country. From the Mathabhanga the Kumar river carries flood water to a portion of the Jessore district, and the Ichamatti, to a limited extent, to the north of the 24-Parganas. Further east, the Gorai takes flood water to the eastern side of the Jessore and Khulna districts. It is true that during the period of low water in the Ganges, *i.e.*, from November to June, little, if any, water passes into these channels from the parent stream, but this does not affect the fact that they are still operative in heightening the land surface of a part of the delta. In the second category we have the greater part of Jessore, Khulna and the 24-Parganas, and the remainder of the Murshidabad district. We find in this country water-courses, such as the Lower Bhairab, the Chitra and the Kabadak, which now receive no flood water from the Ganges. Their channels are far too large for their remaining function as receptacles of the local drainage. The very small slope, which is characteristic of the country, tends to cause them to become choked with aquatic vegetation, and to take the form of elongated tanks in which the flow of water is extremely sluggish. It is channels of this nature which are generally described as dead or silted-up rivers. It is necessary, however, to bear in mind that it is only the connection with the parent stream which has been closed or silted, and that the channels, as existing, are quite competent to receive local drainage and to convey it to tidal waters, which, except with the aid of pumping, is the limit of efficiency of all drainage in a deltaic country. In the Murshidabad district the action of nature has been interfered with artificially by means of the marginal embankment along the left bank of the Bhagirathi, which prevents the inundation which would otherwise occur, and has reduced the Gobra Nala to a condition similar to that of the channels in the Jessore district.

Within the delta the division attains its highest level in the northern part of the Murshidabad district which lies some 75 feet above mean sea level. In the southern portion of the districts of the 24-Parganas and Khulna the land is below the level of the tidal water. This is the case throughout the Sundarbans, where it is necessary to exclude the salt water by embankments as a precedent to reclamation and cultivation, but this tract scarcely comes within the scope of the present enquiry.

The possible tests of local unhealthiness.

6. The task of determining the comparative prevalence of malaria in different local areas within the division as a whole is not an easy one, but there would appear to be three possible lines of enquiry, viz:—

(*a*) the examination of the recorded vital statistics and the census records;
(*b*) the evidence of local opinion; and
(*c*) the facts ascertainable by detailed local medical investigation.

Of these, the last named is the most valuable. Unfortunately the facilities for expert enquiry into the medical history of individual villages are few. Were it the case that the country was studded with competent medical observers recording the facts coming to their notice in the course of practice data would be accumulated at a rate which is at present unattainable. The single Civil Surgeon of each district is, as a rule, too fully occupied with other duties to permit of his undertaking such enquiries, but a series of local observations systematically made, even if covering a small area, would be of greater value than the generalities concerning the health of the district which at present find place in many of the sanitary reports. Under existing conditions, however, such researches usually devolve upon officers specially deputed, and these are not always available at all, and practically never in sufficient numbers to cover the enormous area involved within a reasonable time. Popular opinion can only be accepted as a guide with caution: as usually ascertainable, it is frequently ill-informed, and it tends to be representative of the small section of the community which can make itself heard, and the opinion of which is often based mainly upon the experience of head-quarters or the more conspicuous villages. Finally, the vital statistics of the province suffer from various limitations. It is only since 1892, and more particularly in the later years of the subsequent series, that a considerable degree of accuracy can be claimed for them. Enquiries during 1905 detected the omission to register ·72 per cent. of the deaths checked, but this result has only been achieved after many years of effort, starting from a recorded provincial mortality in 1871 of 4 per mille. Although this inaccuracy of the earlier statistics should be well known, they are not infrequently utilised as conclusive evidence of deteriorating health. Further, the recorded death rates as given in the sanitary reports are calculated upon the unadjusted figures of the preceding census; in the later years of the intervening decades the rates of mortality may, therefore, to some extent be incorrect. Thirdly, the circles of registration do not go below the thana, and the area of a thana is sufficiently large to permit of great variations in the circumstances of different portions of it. Fourthly, although the total death rate as now recorded may be reasonably accurate, the classification of the causes of death, dependent upon the acumen of the village chaukidar, is notoriously misleading.

Analysis of the deaths classified as from "fever."

7. In dealing with the causes of death, the vital statistics recognise the eight* classes noted in the margin, but to the mind of the reporting agency "fever" is the category within which it is simplest to place the majority of deaths which do not present the well-defined symptoms of cholera, small-pox, injury, and, to some extent, plague. That the class "fever" is not synonymous with malarial fever is a commonplace of the sanitary reports, but outside these publications it is not always borne in mind. The first attempt in Bengal to analyse the mixed total returned as deaths from "fever" was made by Captain Rogers, I.M.S., in the course of a special enquiry in the Dinajpur district in the year 1904, when by questioning the surviving

* Cholera.
Small-pox.
Plague.
Fever.
Dysentery and Diarrhœa.
Respiratory diseases.
Injury.
All other causes.

relatives regarding the circumstances of 1,104 deaths reported as from "fever," the conclusion was arrived at that "nearly one-third of the cases returned under the head of 'fever,' which includes 90 per cent. of all deaths in the Dinajpur district, are incorrectly classed as such, while of the two-thirds correctly returned, less than half are due to malarial fevers, while a few others may be cases of various chronic diseases, the histories of which were not sufficient to enable them to be accurately diagnosed." The procedure adopted was admittedly imperfect, but in the absence of any recorded examinations of cases of illness during the life-times of the patients, no alternative method would seem practicable. Action was similarly taken in the course of the recent enquiries by Captain Stewart and Lieutenant Proctor, and the results obtained by them in the different areas dealt with are compared below:—

AREA OF ENQUIRY.	Number of fever deaths enquired into.	PERCENTAGE OF DEATHS DIAGNOSED AS DUE TO—										
		Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and Diarrhœa.	Typhoid.	*Born, feeble.	Leishman Donovan infection.	Other causes.	Doubtful.
Jessore district ...	398	10·2	14·8	7·0	4·8	9·0	11·3	1·8	1·3	1·0	17·3	11·6
Nadia do. ...	195	16·4	23·6	8·2	6·2	7·2	10·7	4·1	·5	6·2	13·3	3·6
Murshidabad do. ...	242	21·6	13·6	10·7	4·1	5·4	15·3	2·5	2·9	1·6	13·6	8·7
Total ...	835	19·6	16·5	8·4	5·0	7·5	12·3	2·5	1·6	2·4	15·3	8·9

NOTE.—It is to be observed that in the case of the Dinajpur district, Captain Rogers calculated somewhat similar percentages upon the deaths actually diagnosed, *i.e.*, excluding doubtful cases.

* Denotes cases of deaths of infants during the first few days of life.

Thus an analysis of 835 deaths scattered over three districts leads to the conclusion that acute and chronic malaria together are responsible for rather more than one-third of the deaths registered as due to "fever," a result analogous to that arrived at in Dinajpur, and which seems likely to be corroborated by a separate enquiry now in progress under the supervision of an Assistant Surgeon in a selected area of the Burdwan district. Looking at the roughness of the approximation, and to the undoubted fact that deaths attributed to other causes may not infrequently be due indirectly to the fact that the constitution had been previously undermined by malaria, we have not considered that any useful purpose would be served by an elaborate calculation from the "fever" death rate of that due to malaria. It will suffice if it is remembered that, so far as can be ascertained, about one-third only of the deaths returned from "fever" are caused directly by malaria. Among children under 10, the proportion is far higher, and is calculated by Captain Stewart and Lieutenant Proctor to amount to 50·5 per cent.; among adults over 20 their percentage is 26·5. The corresponding proportions deducible from Captain Rogers' enquiries are 48·2 and 31·2, respectively.

Other evidence of the extent of malaria in the Presidency Division.

8. As regards the existence of malaria in the living subject, the best evidence adducible is that arrived at by the calculation of the endemic index, *i.e.*, the percentage of children with malarial parasites in their blood, in villages examined during the fever season, but it is not practicable by this method to compare the relative extent of malaria in villages visited at different times of the year, since the endemic index falls rapidly at the close of the fever season. The average figure arrived at by Captain Stewart and Lieutenant Proctor on the basis of the examination of 644 specimens of blood collected in 25 villages in the Jessore district during the latter half of October was 34, with a variation from 50 to 8. A few similar calculations relative to the plains of Bengal by other observers are given in Captain James' *Memoir on Malaria in India*, where of three figures for the Jalpaiguri district the highest was 24·3, and while it might be wished that further data were available, there can be no doubt that the figure arrived at in the Jessore district denotes an extensive prevalence of malaria. For other indication of the existence of malaria in the districts of Jessore, Nadia and Murshidabad, there are the spleen rates taken in the course of the present investigation when, after examination of 13,514 children in 206 villages, a percentage of 55·9 of cases of enlargement of the spleen was arrived at, and in the case of the villages examined in the Jessore district for calculation of the endemic index, it was found that a high spleen rate was practically uniformly accompanied by

a high endemic index. It is reasonable to assume a similar result in the other districts of the division. The adult spleen rate based upon the examination of 417 cases was 49. The remarks of Captain Stewart and Lieutenant Proctor as to the existence of infection from the Leishman-Donovan parasite will be referred to later in dealing with the circumstances of individual districts, but there seems no sufficient reason generally to doubt that the high spleen rates recorded are due to the effects of malaria.

It is not easy from the data on record to estimate the usual spleen rate of malarious tracts in Bengal. Colonel Gregg, Sanitary Commissioner, who made some enquiry in the unhealthy areas of the Presidency and Burdwan Divisions in 1894 found an average rate among ordinary villagers (adult* and children) of 53·64, but it is not quite clear at what time of the year the investigation was made, though apparently about August. Captain Rogers in February 1900, in the district of the 24-Parganas, in eight municipalities† on the east bank of the Hooghly, ascertained an average spleen rate of 24·5, and in eight centres further east of 41 (calculated both on adults and children). In February 1901, in two thanas of the Bogra district reputed to be unhealthy, he ascertained rates of 10·3 and 22·2, respectively (calculated on children only), while in 1904, during the minimum fever season, the same officer calculated rates varying from 28 to 95 (children only) in seven thanas of the Dinajpur district. Even if it be agreed that 50 may ordinarily be taken as the spleen rate of this part of the province, it will be noticed that the average arrived at in the course of the recent enquiry is in excess of that figure.

Comparison of the healthiness of the different districts of the Presidency Division.

9. Applying the test based upon the vital statistics to the comparative salubrity of the different districts of the Presidency Division, the figures of the recorded death rates per mille (*a*) from all causes, (*b*) from "fever" are compiled in Statements I and II annexed for a period of ten years, and the annual averages deducible therefrom are reproduced below :—

DISTRICT.	AVERAGE ANNUAL DEATH-RATE PER MILLE FROM ALL CAUSES.		AVERAGE ANNUAL DEATH-RATE PER MILLE FROM FEVER.	
	For ten years 1896—1905.	For five years 1901—1905.	For ten years 1896—1905.	For five years 1901—1905.
Jessore	37·6	39·2	31·2	32·4
Nadia	37·0	42·0	28·8	33·3
Murshidabad	35·7	37·7	28·0	29·7
Khulna	33·4	32·3	22·0	20·8
24-Parganas	27·4	28·3	18·8	18·3

The total death rate from all causes may be utilised as a convenient check upon deductions to be drawn from the doubtful classification of "fever" deaths only, but it will be observed that the relative positions of the five districts in either scale are the same. A curious feature of the figures is that while over a term of ten years Jessore would appear to have been more unhealthy than Nadia, the position is reversed if the statistics for the last five years only are taken. This result seems to be due to the extreme unhealthiness in Nadia of the years 1902 and 1905, while the figures in different years in that district also exhibit greater variations than in the case of Jessore. It may be taken that over a series of years the latter is the most unhealthy district in the division, although Nadia runs it close. The extreme unhealthiness of portions of the eastern half of the Murshidabad district account for its ranking third in the series, but there is a distinct drop in the figures in the cases of Khulna and the 24-Parganas, the latter being the most salubrious district of the division with a death rate which is not abnormally high. Except for the fact that Khulna ranks as less healthy than the 24-Parganas, the classification perhaps accords generally with the popular impression; it is possible that the attention directed in the 24-Parganas to the condition of the Baraset subdivision has led to an idea that the district, as a whole, is more unhealthy than it is. The recent detailed medical enquiries have not touched these two districts, while they have not been sufficiently extended to permit of a full comparison of the health conditions even in the remaining three. However, so far as they go, upon the basis of spleen rates taken in children under 12 years of age, and excluding the Gangni thana of Nadia, in which the results were complicated by the existence of Leishman Donovan infection, Jessore would appear to be more malarious than Nadia, and Nadia than Murshidabad. The fact that the spleen rates were taken in Jessore during the fever season (October—December), in Nadia in January, and in Murshidabad in February, would have a tendency to show the districts examined later as comparatively more healthy than they are, though not probably to an extent vitiating the general conclusion. In any case the rates cannot be considered as other than high.

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* It was the opinion of Captain James (*Malaria in India, Scientific Memoirs, No. 2*) that in the plains in Bengal the spleen rate increases with advancing age.

† In the Halisbahar municipality in the fever season 1906 the Deputy Sanitary Commissioner noticed rates varying from 25 to 88.

DISTRICT.		Spleen rate ascertained in course of recent enquiry.
Jessore	...	62·3
Nadia	...	53·3
Murshidabad	...	41·1

The relative prevalence of malaria in different parts of the same district.

10. But in considering the prevalence of malaria in different districts as a whole, the unit of comparison is too large to permit of any very definite conclusion as to the causes governing the distribution of the disease, unless there is a very marked distinction between the physical characteristics of the districts compared, and this, in the case of the districts of the Presidency Division, with the exception of the portion of the Murshidabad district west of the Bhagirathi river, there is not. It is necessary therefore to carry the comparison further, as between different portions of the same district, after which it remains to be seen whether the features which mark the unhealthy areas differentiate them in any way from the tracts in which malaria is not so prevalent. It has been already mentioned that the recorded vital statistics for rural areas, and those only as in the office of the Sanitary Commissioner and not as reproduced in the published reports,* do not carry us below the unit of the thana, and we proceed to examine the prevalence of malaria in each district of the division from this standpoint.

The Jessore District.

11. In his manual of the district (1870) Mr. Westland divided the present district of Jessore into two portions with distinctive physical characteristics. Following his description, and drawing an imaginary line from south-west to north-east from Keshabpur to Muhammadpur, the area to the north and west may be classed as high land in which the rivers are above the reach of the tides and are confined between their banks. The general fall in the levels of the country is from north-west to south-east, and the river channels and lines of drainage follow this direction. As has been already mentioned, this part of the district now receives little, if any, flood water from the Ganges, and the channels having to carry only local drainage, the volume of which is small and in no proportion to their natural capacity of discharge, have greatly deteriorated and are full of weeds. To the south and east are low-lying marshy lands, the rivers are affected by the tides, and the whole region for some months in the year is practically under water. The drainage can be said to be in no particular direction. Partly owing to deterioration in the arterial lines of drainage the district nowhere presents conditions which are favourable to health. In Statement III will be found details of the different thanas in the district classified according to the order of their annual average mortality (*a*) from all causes, and (*b*) from fever during the quinquennium 1901—1905, but it will be seen that in either list the relative positions of individual thanas are approximately the same; Kotchandpur is, perhaps, less feverish than might be presumed from its total death rate. The most noticeable feature of the figures is the uniformity of the different rates; they are all high, and there is not much divergence between the first and last. It is very difficult, therefore, to class one tract as more unhealthy than another; the whole is unhealthy. Nevertheless, taking the district annual average fever rate for the same period, 32·4, we may, perhaps, say that in Jessore any rate over 35 is especially severe and under 30 comparatively favourable, but the fact that these terms are comparative only should be emphasised. In this view the worst thanas are Jhenida to the north-west, Gaighata in the south-west corner, and Salikha and Bagharpara towards the

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* An attempt made in the Nadia district to work out even a few village death rates from the existing records led to nothing.

centre and east. The thanas which are best off comprise Barkalia and Lohagara in the south-east corner, Kotchandpur on the western, and Gadkhali on the southern boundary. Turning to the statistics which are reproduced in the same statement showing the percentages of fluctuation in the population at the three censuses since 1881, ample confirmation is apparent of the unhealthiness of the district, and while in this general result other diseases of course played a part, we are justified, looking at the proportion borne by the fever death rate to the total mortality, in assuming that fever was responsible mainly for the decrease in population which is so marked. Every thana showed a decrease between 1891 and 1901 with the exception of Barkalia and Narail, and the large reduction in the Magura subdivision (thanas Magura, Muhammadpur and Salikha) was particularly noticeable. The same deduction may be drawn from the totals of births and deaths during the quinquennium 1901—1905, and the excess of deaths in thanas Narail, Salkopa, Magura, and Jhenida is very striking. Only in Barkalia and Lohagara were the births in excess. The unhealthiness of the district being as diffused as it is, it is only to be expected that the local opinion of the most unhealthy areas will be somewhat indefinite, since everyone will be inclined to attach the greatest importance to the particular area of which he has personal experience. As a general impression, which is admitted not to allow of proof, the District Magistrate (Mr. Sen) states that public opinion considers that the general health has deteriorated within the last fifty years, but that within the last ten years there have been signs of improvement except in Magura and Narail. Captain Stewart and Lieutenant Proctor consider that the general local idea points to the Jhenida and Sadar subdivisions as more unhealthy than those of Magura and Narail, and Mr. Sen cites Narail as the healthiest part of the district. Such general statements are not, of course, of great value. Captain Stewart and Lieutenant Proctor give figures showing that there is practically no difference between the different subdivisions taken as a whole, although it is the case that the comparatively healthy thanas of Barkalia and Lohagara are situated in the Narail subdivision which may account for its reputation. As to recent deterioration, Jessore town was described as unhealthy early in the nineteenth century, and as a more modern instance of the inaccuracy which is liable to characterise allegations on this point, we have the statement made to us that the Narail subdivision was quite free from malarial fever even ten years ago, whereas Captain Stewart and Lieutenant Proctor draw attention to the fact that the Narail thana is mentioned as noticeably feverish in the sanitary reports of 1876-77. With reference to the Magura subdivision, the evidence of the census of 1901 does certainly point to great recent unhealthiness, as also do the five years' figures of births and deaths. The thanas which the local officers report to us as specially unhealthy are the greater part of Jhenida, Kotchandpur and Salkopa (constituting the Jhenida subdivision), and parts of the Sadar, Bagharpara, Moheshpur, Sarsha, Gaighata, Narail, Lohagara, Magura, Muhammadpur and Salikha thanas, noticeably along the course of the Bhairab and Betna-Jamuna rivers (thanas Sadar, Bagharpara and Moheshpur, as regards the Bhairab, and Moheshpur, Sarsha and Gaighata adjacent to the Betna-Jamuna). Of this list only Jhenida, Bagharpara, Gaighata and Salikha occur among the particularly unhealthy thanas which we have noted above, but these comparisons in the case of the Jessore district are peculiarly arbitrary. For instance we have mentioned Lohagara as healthy, but Mr. Sen states that the villages therein along the Barasia river are very much the reverse. Local enquiry alone will verify these details, and when we come to the recent investigation of Captain Stewart and Lieutenant Proctor, a glance at the map accompanying their report fully corroborates their statement that "high spleen rates were found in all four subdivisions" (Bongaon was not visited), "and were not localised in any particular part of the district." Of the Jessore district, as a whole, therefore, it may be said that—

(*a*) the whole district is extremely unhealthy;
(*b*) malarial fever prevails extensively everywhere;
(*c*) by a rather arbitrary comparison, the thanas of Jhenida, Gaighata, Salikha and Bagharpara are the most malarious;
(*d*) the least malarious are thanas Barkalia, Lohagara, Kotchandpur, and Gadkhali.

The Nadia District.

12. It is impossible to differentiate between the physical features of the different portions of the Nadia district. The whole area consists of an alluvial plain, which still receives a fair share of the Gangetic flood through the channels of the Jalangi, Matabhanga and Gorai, but is subject to general inundation in years of high flood only. Backwaters, minor streams and swamps intersect it in all directions. A low-lying tract of black clay soil, known as the *Kalantar*, stretches from the adjoining district of Murshidabad through the Kaliganj and Tehatta thanas on the west, but these areas do not present any special features from the point of view of health. A comparison between the different thanas arranged according to the average (*a*) total and (*b*) fever mortality during the five years 1901—1905 (Statement IV) does not disclose any marked variation in the position of each. Santipur is comparatively rather less feverish, and Kushtia rather more so, than its position in the list according to total mortality would presume. Taking the average annual district death rate from fever for the same period, 33·3, it may be said that those thanas which have a corresponding rate of 35 and over are specially unhealthy, and those with a rate of 30 and under comparatively healthy, looking to the general conditions of the district. On this basis the most unhealthy thanas in Nadia are those of Gangni and Karimpur adjoining one another on the north-west, and Jibanagar, Kumarkhali and Nayapara on the east. The more healthy thanas comprise those of Krishnagar, Chapra and Meherpur, forming a little strip from south to north in the centre of the district, and Chakdaha in the extreme south. It is difficult to connect the figures showing the variations in population at the three censuses of 1881, 1891 and 1901 with a theory of the progressive deterioration of health in the thanas which now show the highest rates of mortality from fever, but the outbreaks of epidemic fever in the district between 1861 and 1864, and again between 1880 and 1885, have complicated the conclusions as to normal health which may be deduced from the various fluctuations. In the census report of 1901 the thanas of Ranaghat, Santipur, and Chakdaha (comprising the Ranaghat subdivision), Krishnagar and Kumarkhali are mentioned as specially malarious, but only in the case of Kumarkhali is this borne out by the figures of mortality from fever between 1901 and 1905. As regards Karimpur, recently particularly feverish, the census report notes the falling off in population between 1891 and 1901 as difficult to explain. The tracts reported to us by the District Magistrate, " after consulting the local officers, old residents and well known zamindars," as specially unhealthy are Kumarkhali, Jibannagar, Chakdaha, Gangni, Alamdanga, Daulatpur, and some villages in the Meherpur and Krishnagar thanas. Except as regards Kumarkhali, Jibannagar and Gangni the figures of mortality quoted scarcely support the statement, while the further allegation that " almost in every village in the Meherpur* subdivision and in some villages of the Kumarkhali, Daulatpur and Alamdanga police-stations malaria fever has increased considerably in recent times" requires further verification before it can be accepted. A comparison between the total number of births and deaths registered during the five years 1901—1905 shows an increase of population in the thanas of Krishnagar, Chapra, Kaliganj, Daulatpur, Meherpur and Alamdanga only. The local enquiries of Captain Stewart and Lieutenant Proctor in Nadia were too brief to permit of a comparison covering the whole district, but in the three thanas of Gangni, Kumarkhali and Jibannagar total spleen rates of 80, 47 and 67 were recorded, although the number of villages examined (43 in all) was small. The most interesting point elicited was the probable presence in the Gangni thana of Leishman-Donovan infection in considerable amount, which renders nugatory the spleen test as evidence of the prevalence of malaria. In respect of malaria only it was surmised that the three thanas suffer about equally. The statement of the villagers in Gangni that fever had been severe within the last two or six years only is noticeable, and is consistent with the fact that between the censuses of 1891 and 1901 the thana showed an increase of population of 8·5 per cent., *i.e.*, was not particularly unhealthy. Concerning the nature of the Leishman-Donovan parasite our knowledge is at present limited, but the disease is not

* Thanas Meherpur.
„ Gangni.
„ Karimpur.
„ Tehatta.

malarial; whether it is found in other portions of the district is an important question demanding further investigation. Looking to the available evidence touching the medical history of the district, we arrive at the following conclusions:—

(*a*) The whole district is very unhealthy;
(*b*) similarly, the whole district is feverish;
(*c*) investigation upon a small scale has demonstrated the fact that some of the fever is probably due to Leishman Donovan infection, but that the greater part is malarial;
(*d*) the most malarious thanas are those of Gangni, Karimpur, Jibannagar, Kumarkhali and Nayapara;
(*e*) the least malarious areas are the Krishnagar, Chapra, Chakdaha and Meherpur thanas.

The Murshidabad District.

13. As might have been anticipated from what has been already said concerning the physical features of the Murshidabad district on either side of the Bhagirathi river, it is possible in its case, unlike that of the districts of Jessore and Nadia, to differentiate sharply between the health conditions of different areas. Referring to the statistics in Statement V it may be noted, as elsewhere, that the series of thanas in order of total mortality corresponds very closely to that according to the death rate from fever, the only marked exception being Shamshirganj, which is slightly lower on the fever list than on that of the general mortality, but in either view is fairly healthy. Taking the average annual district death rate from fever (1901—1905) as 29·7, it may be concluded that the thanas which exhibit a rate of 25 and under are fairly healthy, and those in excess of 40 noticeably the reverse. It will at once be seen that in Murshidabad the healthy thanas of Khargaon, Kandi, Barwan, Gokaran and Bharatpur (constituting the Kandi subdivision) occupy a compact block in the south-west corner, while Raghunathganj and Mirzapur, along with Shamshirganj, Suti and Sagardighi (the rates for which are only slightly higher) lie to the north-west—all (except Raghunathganj) to the west of the Bhagirathi. The only other thanas on that side of the river are Nobogram, which is neither specially healthy nor the reverse, and Assanpur which falls within the area of high rates. The feverish thanas group themselves in a well-defined tract running north to south along the east bank of the Bhagirathi from Bhagwangola, through Manullabazar, Shahanagar, Daulatbazar, Assanpur (west of the Bhagirathi), Sujaganj and Gorabazar. The average annual mortality from fever (1901—1905) in these thanas runs higher than any rates in either Jessore or Nadia, with the one exception of the Gangni thana in the latter, which exceeds the rate of Bhagwangola only. Hariharpara adjoining to the east is only slightly less unhealthy. The eastern portion of the district, Gowas, Jalangi, and Noada, stands midway in point of health between the two areas above defined. The variations in the total population recorded in the three censuses, especially during the decade 1891—1901 (the figures for the earlier ten years were affected by epidemic fever) corroborate these conclusions in a marked manner. The district as a whole showed a fair increase in population at the last census (+6·6 per cent.), but all the noticeably unhealthy thanas with the exception of Bhagwangola and Hariharpara, and Gorabazar and Asanpur which were practically stationary, showed a falling off, although it is to be remarked that the declining prosperity of the trade which used to centre around Murshidabad and Cossimbazar has also contributed to this result. The only other decrease, in Suti, which is a healthy area, was due to emigration, not illness. Turning to the totals of births and deaths during the five years 1901—1905, we get further evidence to the same effect. All the eight thanas mentioned above as particularly feverish show an excess of deaths, with the exception of Bhagwangola in which the increase was, however, small. The only other thanas similarly situated are Jalangi and Noada, which have not been classed as specially unhealthy, although the fever rate in the former (36·7) is considerably above the district rate. The health conditions of the district being so well defined, the local opinion as to their distribution accords with what has been said above. The recent investigation of Captain Stewart and Lieutenant Proctor touched rapidly the most unhealthy

tracts as above defined, and it is in accordance with the conclusions already drawn that the tract comprised in the Manullabazar, Shahanagar, Daulatbazar, Sujaganj, Gorabazar and Hariharpara thanas yielded the high average spleen rate of 62·6. The rates recorded in the Bhagwangola thana were perhaps rather lower than might have been expected, and it is not quite clear why, for the purpose of an average, this thana, which on the figures of mortality is noticeably feverish, has been grouped with that of Diwansarai (referred to as Lallgola) which is not. As explained in Captain Stewart's report, the rate of 33·6 for Assanpur cannot be accepted as a true one. In this district the presence of Leishman-Donovan infection to any extent was not detected, but this pronouncement should be accepted with caution in view of the decided opinion of Major Nott, I.M.S., who knew the district well, given in the annual sanitary reports for 1904 and 1905, that this disease was unquestionably very prevalent. As regards the thanas of the Murshidabad district the facts then may be summarised as follows:—

(*a*) Some portions of the district are extremely unhealthy, more so than Jessore or Nadia ; other portions are comparatively healthy ;
(*b*) fever is similarly distributed ;
(*c*) local investigation has shown that the fever is malarial, but the presence or absence of Leishman-Donovan infection is an open question ;
(*d*) the most malarious thanas are Bhagwangola, Manullabazar, Shahanagar, Daulatbazar, Sujaganj, Gorabazar, Hariharpara, Assanpur, and perhaps Jalangi ;
(*e*) the least malarious areas are comprised in the whole of the Kandi subdivision, and in the thanas of Shamshirganj, Suti, Raghunathganj, Mirzapur and Sagardighi.

The Khulna District.

14. The Khulna district exhibits four areas which may perhaps be differentiated, namely, that to the north-west, where the land is raised ordinarily above flood level, the population is dense, and the general conditions are similar to those in Jessore ; the north-eastern portion from the Jessore boundary southwards to the latitude of Bagerhat, where the land is low and covered with swamps, but the country is more open and there is less jungle ; the central portion representing the area of the Sundarbans which has been cleared and populated in fairly recent times ; and the uncleared Sundarbans to the south. The last named tract may be excluded from consideration. *A priori* it would seem probable that the central portion of the district would be more healthy than the northern strip, and the statistics show this to be the case, but the district as a whole is not abnormally feverish. The figures of total mortality in different thanas (Statement VI) bear a fairly constant relation to the death rates from fever, except perhaps in Magura, which is rather more feverish, and Assasuni rather less so, than the total death rate only would presume. Judging from the average annual fever rate in the whole district (1901—1905), namely 20·8, the thanas showing a proportion per mille of 25 and over may be classed as specially unhealthy, and those of 15 and under as the reverse. Upon this basis we find in Khulna the healthy thanas of Kaliganj and Paikgacha closely followed by Assasuni and Rampal, all along the central line bordering upon the Sundarbans, while Kalaroa and Magura in the north-west corner, and Mollahat on the north-east, all show fever rates which, for the district, are high. The fluctuations in population exhibited by the census figures corroborate these results, except in the case of Mollahat (+5·6). The population in Magura between the two last censuses was practically stationary, while in Kalaroa (—10·1) it decreased noticeably. Satkhira (—1·7) also showed a small diminution, which its position in the fever list would scarcely anticipate, and the census report of 1901 mentions unsatisfactory health as a cause, although loss of trade by the diversion of the boat routes was also operative. The statistics of total births and deaths for five years, 1901—1905, show an excess of births everywhere, although it was very small in Mollahat, and not large in Kalaroa, thus according generally, though not conspicuously, with the deductions made above. Local opinion is perhaps inclined to consider the district as more malarious than the statistics corroborate, and the District Magistrate (Mr. Ahmad) remarks that "there is a

general belief that the district is malarious, but there is no evidence to suppose that malarial fever has considerably increased in any part in recent times, nor is there evidence to support the fact that there has been in recent times any decrease of population or failure to cultivate land on this account." The specially unhealthy areas particularly named by the local officers consist of villages scattered throughout the district, and the statement does not permit of verification without detailed enquiry. Local opinion was particularly emphatic regarding the unhealthiness of Satkhira, and the decrease of population between 1891 and 1901 is some corroborative evidence, but the figures scarcely support the statement made to us that malaria is "rampant" throughout the subdivision, and we are inclined to think that the bad reputation of the subdivisional head-quarters is partly due to the fact that it is more conspicuous than other villages. The only detailed local enquiry of recent times touching the Khulna district is that of Captain Sinha, I.M.S., Deputy Sanitary Commissioner, made in March 1895 in the Kalaroa thana, where an average spleen rate of 37·4 was found, about half the cases examined being adult and half children. So far as we can judge, there is no special reason for supposing the main proportion of fever in Khulna to be other than malarial, and we submit the following conclusions regarding the district :—

(*a*) It is not conspicuously unhealthy in any part;
(*b*) malaria is prevalent, but not especially so;
(*c*) the most malarious thanas are Kalaroa, Mollahat, Magura and perhaps Satkhira;
(*d*) the least malarious are Kaliganj, Paikgachha, Assasuni and Rampal.

The 24-Parganas.

15. Following the provincial census report of 1901, the district of the 24-Parganas may be divided into five blocks according to their physical features, namely :—

(1) The thanas on the east bank of the Hooghly (Naihati, Nawabganj, Barrackpore, Khardaha, Baranagore and Budge-Budge) lying higher than those further inland, and with a better drinking supply.
(2) The northern and central thanas (Habra, Diganga, Baraset, Dum-Dum, and Tollyganj) areas of silted rivers, swamp and jungle.
(3) The eastern thanas (Baduria and Basirhat) where the cultivators are sturdy and well-to-do.
(4) The southern thanas (Haroa, Bhangar, Sonarpur, Baruipur, Vishnupur, Falta, Diamond Harbour and Magrahat) where the country is more open, with less jungle, and during the monsoon enjoys a sea breeze.
(5) The Sundarbans thanas of Hasanabad, Canning, Jainagar, Mathurapur and Kalpi.

From this description the areas of most malaria might be looked for in the second division, and the remainder might be expected to be comparatively healthy, but upon the basis of the vital statistics it will be seen that it is the thanas of the first class which are the most feverish. The explanation possibly lies in the fact that the census report had more in mind the municipal portions of these thanas along the bank of the river; the statistics quoted are of rural areas, away from the river, the conditions of which approximate more to those of the country further east. The annual average statistics of mortality (*a*) from all causes and (*b*) from fever (Statement VII), place the different thanas in approximately the same relative order, but Tollyganj and Basirhat are rather more feverish, and Diamond Harbour considerably less so, than the figure of total death rates would show. Upon the basis of the district fever rate of 18·3 we may perhaps class rates of 25 and over as unhealthy, and of 15 and under as the reverse. If so, the specially unhealthy thanas in the 24-Parganas are Dum-Dum,* Khardaha, Barrackpore, Naihati and Nawabganj, on the east bank of the Hooghly, north of Calcutta, and Diganga and Habra adjoining them, further inland, to the east. The healthy thanas are Bhangar, Matla, Diamond Harbour and Budge-Budge, all, as might be expected, to the south, towards the sea. The conclusions to be drawn from the census fluctuations are obscured by the shifting of the population due to the opening of new industrial centres, etc. It is probable that this has more than made good any loss by disease in Barrackpore, Khardaha and Naihati, all of which show an increase during the decade 1891—1901, but the increase in Dum-Dum (1·4) was very small, and in Nawabganj, Diganga, and Habra there was a decrease which is in accordance with the fever rates, although a portion of the decrease seems also to have been due to migration, partly, however, on account of the unhealthiness of these localities. All the healthy thanas show a good increase: the apparent decrease in Haroa was not due to considerations of health. We may expect clearer corroboration from the totals of births and deaths for the five years ending 1905, and this is the case as regards Khardaha,* Nawabganj, Barrackpore and Naihati, which all show an excess of deaths, and Habra, where the figures are practically equal. Diganga exhibits an excess of births, which is curious, and there must apparently be some other reason to account for the defect of births in Jaynagar, which is not unhealthy. In the matter of public opinion, as in Khulna, we consider the tendency is to class the district as more unhealthy than it is. This is intelligible; grievances can be easily represented in Calcutta, and the standard of comparison is perhaps higher than in less advanced districts. Apart from individual villages the District Magistrate (Mr. Bernard) names the thanas of Baraset, Habra, Diganga, Dum-Dum, Barrackpore, Nawabganj, Khardaha and Naihati as specially unhealthy, and the statistics bear out this view, but in the case of Haroa, Falta, Jaynagar, Mathurapur and Magrahat, which are also mentioned, this is scarcely the case for the area of the whole thana, but the reference is apparently to particular portions only. The only recent detailed local enquiry in this district was made in 1900 by Captain Rogers, as already referred to, when urban spleen rates of 55 (Gobardanga), 52 (Basirhat), 52 (Baraset), 56 (South Barrackpore), and 68 (North Dum-Dum) were taken among others, all pointing to the prevalence of malaria. To sum up, therefore, the local conditions :—

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* The rate of 47·67 for Dum-Dum is incorrect, owing to a mistake made in the rate given in the annual report for 1904. The thana is unhealthy, but not so to the extreme degree apparently indicated.

(*a*) The district as a whole is not abnormally unhealthy, though some portions of it return high rates of mortality ;
(*b*) similarly, it is not, as a whole, specially malarious ;
(*c*) the noticeably malarious thanas are those of Dum-Dum, Khardaha, Barrackpore, Naihati, Nawabganj, Diganga and Habra ;
(*d*) the least malarious areas are the Bhangar, Matla, Diamond Harbour and Budge-Budge thanas.

Comparison of the most unhealthy thanas in the Presidency Division as a whole.

16. Having now scrutinised the circumstances of each district of the division, it is instructive to compare the thanas in the whole division which are characterised by the greatest prevalence of malaria. We take an annual average death rate from fever of 30 and over as denoting special unhealthiness, and particulars regarding the thanas answering to this description are collated below:—

Serial No.	District.	Thana.	Average annual death rate from fever (1901 to 1905).	Area.
				Sq. miles.
1	Murshidabad	Manullabazar	49·29	9
2	Ditto	Shahanagar	48·61	24
3	Ditto	Assanpur	48·40	19
4	24-Parganas	Dum-Dum	47·57	50
5	Murshidabad	Sujaganj	47·26	18
6	Ditto	Daulatbazar	43·48	63
7	Ditto	Gorabazar	42·22	19
8	Nadia	Gangni	40·96	126
9	Murshidabad	Bhagwangola	40·29	110
10	Nadia	Karimpur	40·22	193
		Carried over ...	......	631

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* It will be noticed that Khardaha, Nawabganj, Barrackpore and Dum-Dum are all small areas.

Serial No.	DISTRICT.	Thana.	Average annual death rate from fever (1901 to 1905).	Area.
				Sq. miles.
		Brought forward ...	......	631
11	24-Parganas	Khardaha	39·96	17
12	Nadia	Jibannagar	39·15	77
13	Do.	Kumarkhali	38·65	153
14	Murshidabad	Hariharpara	37·74	98
15	Jessore	Jhenida	37·31	165
16	Do.	Salikha	37·12	90
17	Murshidabad	Jalangi	36·70	192
18	Nadia	Nayapara	36·36	177
19	Jessore	Gaighata	35·95	94
20	Murshidabad	Gowas	35·09	157
21	Jessore	Bagharpara	35·03	105
22	Do.	Magura	34·93	222
23	Nadia	Chuadanga	34·86	112
24	Jessore	Muhammadpur ...	34·82	113
25	Nadia	Tehatta	34·08	180
26	Jessore	Kaliganj	33·98	141
27	Do.	Salkopa	33·46	246
28	Nadia	Kushtia	33·37	123
29	Do.	Daulatpur	33·31	143
30	Do.	Hanskhali	33·30	104
31	Jessore	Narail	33·22	232
32	Do.	Bongaon	33·20	224
33	Do.	Moheshpur	32·94	201
34	Nadia	Kaliganj	32·84	109
35	Do.	Nakasipara	32·74	135
36	24-Parganas	Barrackpore	32·33	13
37	Murshidabad	Noada	32·09	88
38	Nadia	Kissenganj	31·51	57
39	Do.	Alamdanga	31·45	132
40	Do.	Ranaghat	31·40	161
41	24-Parganas	Naihati	31·41	96
42	Jessore	Keshabpur	31·29	100
43	Do.	Manirampur	31·06	219
44	Nadia	Damurhuda	31·03	116
45	Jessore	Jessore	30·69	231
46	Do	Sarsha	30·53	130
47	Nadia	Santipur	30·14	74
48	Murshidabad	Nobogram (Kalianganj) ...	30·01	122
		Total ...	......	5,780

DISTRICT.	No. of thanas.	Area.
Jessore ...	15	2,513
Nadia ...	17	2,172
Murshidabad	12	919
24-Parganas	4	176
Total ...	48	5,780

Under this classification it will be observed that Khulna is not mentioned at all. For the rest 48 thanas in the division, covering an area of 5,780 square miles, are specially malarious, the greater part being in Jessore and Nadia, with a moderate area in Murshidabad, and a small area in the 24-Parganas, but for intensity of malaria the first place must be given to certain thanas of the district of Murshidabad.

Impossibility of comparison of the unhealthy villages in the Presidency Division.

17. Such being a general statement in order of the unhealthy thanas of the division, the question remains whether the comparison can be carried below that unit, *i.e.*, to the village. The possibility of deducing from a study of the non-malarious villages the peculiar conditions which differentiate them from others in which the disease is prevalent was raised in connection with the annual Sanitary Report for 1900, and is discussed in that of the succeeding year. The reply then given was that no villages were immune, and this is probably true (though Captain Stewart and Lieutenant Proctor give the spleen rate of one village in Jessore, Singha, as 0), but it is certain that while most villages are feverish, some are less so than others, and a comparative examination in greater detail than is possible from the thana results only would be valuable.

Unfortunately the necessary data are very incomplete. In the absence of vital statistics for individual villages or village groups, the only source of information is local enquiry covering an area sufficiently large to justify a general deduction as to the balance. So far the only enquiries of any duration affecting the Presidency Division have been that recently held, and that of Captain Rogers in the riparian municipalities on the Hooghly, which has been already quoted. The investigation of Captain Stewart and Lieutenant Proctor touched 206 villages in three districts which contain between them 11,973 villages; in the division there are over twenty thousand villages. The villages visited were, of course, selected in the areas which had the local reputation for malariousness, and are perhaps therefore more typical of the conditions in the most unhealthy tracts than might at first sight appear, but on the other hand it will be seen subsequently that villages of apparently similar situation vary curiously in the matter of health. The relation of situation to the health of villages is discussed in greater detail below, but in answer to the first portion of the reference to us requesting the specification of the malarious areas of the Presidency Division, and apart from the instances of the few villages examined, we can only offer the foregoing comparisons (*a*) of the districts of the division as a whole with one another; (*b*) of the different thanas within each district individually; and (*c*) of the most malarious thanas within the whole division.

DISTRICT.	No. of villages. (1901 census).
Jessore ...	4,894
Nadia ...	3,411
Murshidabad ...	3,668
Khulna ...	3,441
24-Parganas ...	5,082
	20,496

With the view of securing fuller information in the future we would suggest the advisability of an experimental compilation of vital statistics according to chaukidari unions, more especially in an area in which, by reason of its known unhealthiness, greater detail than is at present accessible would be useful. Where the unions have been properly formed (and in various districts they have been recently revised), the limits of the villages comprising them should be accurately known and noted on the maps, together with the population inhabiting each. The chaukidars in each union are known to the police, and the tabulation of the vital statistics according to unions instead of by the thana as a whole, while more elaborate, should not be insuperably difficult. The area of a union may be taken roughly as 10 square miles, and were the statistics available for these smaller blocks, it is probable that the marked unhealthiness of some areas would attract attention, instead of being lost sight of, as at present, in the general figures of the whole thana. The result would be enquiry, and possibly some addition to our knowledge of the conditions governing disease.

CHAPTER III.

THE CAUSES OF MALARIA IN THE PRESIDENCY DIVISION.

The early history of malaria in Bengal.

18. Before proceeding to the discussion of the causes of malaria, more particularly whether it is to be attributed in the Presidency Division to obstructed or defective drainage, it is relevant to note briefly the history of the disease in Bengal, and the local administrative literature on the subject as distinct from more purely scientific papers. Previous to the middle of last century, the records are exceedingly vague, and the statement which is not infrequently made that certain places were sanitaria in recent times is not easily verified. Thus the census report of 1901 speaks of Nadia as "once famous as a health resort," and there is a widely held idea that the health conditions of the tract upon the east bank of the Hooghly have deteriorated, but it is possible that these impressions have been based upon the experience of a few centres, which happened to attract attention. As regards the Presidency Division, we know that Calcutta, from the earliest days of its foundation, was extremely malarious. Mr. Westland speaks of Jessore town as bearing the reputation of unhealthiness in 1800. Major Walsh, I.M.S., in his history of the Murshidabad district, speaks of the town and neighbourhood of Berhampur as having been extremely unhealthy, at any rate since 1813, and quotes the Marquis of Hastings in 1817 as to the "extraordinary unhealthiness of Murshidabad." Hamilton in the *East India Gazetteer* (1815), evidently referring to the fever season, remarks of Bengal generally that "if the rains break up early in September, the weather is intensely hot, and the inhabitants, especially the European part, become very sickly." Dr. Elliott, writing in 1863, notes that "a peculiar type of fever was prevalent in Jessore for many years previous to its first appearance in the district of Nadia," and traces it back to 1824. The reports of the Sanitary Commissioner date from 1868, and writing of that year, the Civil Surgeon of Jessore (Dr. McLeod) observes that "I consider both station and district decided unhealthy. I have no reason to suppose that either district or station are more or less healthy, or rather unhealthy, in later than earlier years." Of Nadia, in the same year, the Civil Surgeon remarked "intermittent fevers are common all the year round." We lay some stress on the point since some comments on the insalubrity of various areas would infer that the present condition of affairs is of comparatively recent date, arising from causes which should have been preventible. There is little justification for this belief. It will be shown below that the causes tending to the prevalence of malaria are of long standing, and it is only reasonable to hold that the disease has been long present also. Naturally, the question of possible remedy is greatly complicated thereby.

The modern history of malaria in Bengal.

19. Apart from the usual annual reports, etc., the more modern literature of malaria in Bengal centres round three epidemic outbreaks, since the last of which there have been a few special enquiries into the general prevalence of the disease, culminating with the appointment of the present Committee. These epidemics were as follows :—

(*a*) The epidemic in Nadia, Baraset and Hooghly and a few villages in Burdwan (traceable from an earlier date in Jessore), which first attracted attention in 1861, was reported upon by Dr. Elliott in 1863, was investigated by a Committee (usually referred to as the Epidemic Commission) under the presidency of Mr. Anderson in 1864, and which may be said to have ceased in that year.

(*b*) The epidemic (in a sense the continuation of the earlier outbreak in the Hooghly district), which became particularly severe in Hooghly and Burdwan in 1869, and gradually spread to Midnapore, Birbhum and Bankura. Villages in the districts of the 24-Parganas, Nadia and Jessore were affected, but the outbreak was, for the most part, in the Burdwan Division. It commenced to abate in 1874. During its continuance it was reported upon by numerous medical men.

(*c*) The epidemic in Nadia and Jessore between 1880 and 1885, which was enquired into by the Nadia Fever Commission in 1881-82.

There was an outbreak of fever in Dinajpur and Rangpur between 1872 and 1879, but it was not specially investigated. Since 1882, the only detailed local enquiries concerning malaria have been those of Captain Rogers, I.M.S., namely, in the riparian municipalities along the Hooghly (1900), in Bogra (1901), and in Dinajpur (1904). A brief enquiry was made in the Kalarooa thana of Khulna by Captain Sinha, I.M.S., in 1895, and in Faridpur by Captain Stevens, I.M.S., in 1901. The Malaria Committee of the Royal Society (1901) visited Bengal in the course of their tour, but we are concerned now rather with the researches of local officers.

The important point to which we would draw attention is that the bulk of this literature is prior to the days of the theory of the conveyance of malarial infection by the mosquito, which in its recent developments may be said, perhaps, to date from Major Ross' researches of 1897-98, although its present general acceptance may be put some years later. The Epidemic Commission of 1864 wrote in the days of the miasm theory which they considered "a substance *sui generis*, probably generated in the soil, and apparently requiring at least one agent for its creation in large quantities, viz., damp." The investigations of different officers into the Burdwan outbreak originated many theories, but little certainty, and in 1872 it was remarked by Government that "as regards the causes of the disease and its ultimate prevention there is still a mystery." The Nadia Fever Commission of 1882 apparently accepted the view of their President (Dr. Lidderdale) that the disease was due to a germ in the soil. Since the days of the mosquito theory, the special enquiries into malaria which have been held in Bengal have been few, and we are strongly of opinion that a case exists for further research. At the same time enquiry should be systematic, and in no larger area than can be completely coped with. Such a procedure would be calculated to lead to more valuable results than isolated investigations ordered at intervals and covering so extensive a stretch of country as a division. The difficulty is, no doubt, mainly one of the lack of officers who can be deputed for the purpose, but until our knowledge can be said to be more complete than it is at present, we advocate an attempt to make some systematic investigation during each fever season. Data would thereby be collected, and at any rate the facts as to the prevalence of malaria would be more exactly known. The high death rate obtaining in parts of Bengal from this cause is ample justification for such a course. Complete prevention can never probably be hoped for, but at any rate the possibility of remedy rests primarily upon the correct ascertainment of the conditions governing the problem. It was recognised in the Government Resolution dealing with the provincial Sanitary Report for 1902 that benefits were likely to accrue from such special enquiries, and Captain Rogers' report upon the Dinajpur district was the outcome of the orders then passed. The recent deputation of Captain Stewart and Lieutenant Proctor has, of course, followed at a fairly short interval, but these officers would probably be the last to claim that the field for enquiry is exhausted. No final solution is likely to rest solely upon any one investigation, and results can only be hoped for gradually from the accumulated experience of many. It is therefore the need of regular continuous research upon which we would lay emphasis, undertaken as the usual annual procedure rather than under special orders under the instigation of some local outbreak of unusual severity.

The causes of malaria as reported upon by Captain Stewart and Lieutenant Proctor.

20. The investigation of "the causes of malaria" for the purposes of the present enquiry was mainly directed towards ascertaining the influence of obstructed drainage. The specific "cause of malaria" is infection by particular varieties of the female anopheles mosquito, which in their turn have derived infection from the blood of persons suffering from malaria, and the report of Captain Stewart and Lieutenant Proctor, after the presence of malaria had been proved, was directed rather to a consideration of the conditions characteristic of the areas in which malaria was prevalent, more particularly in respect of the alleged obstructions to

drainage, by the improvement or alteration of which some amelioration in the severity of the disease might be anticipated. These conditions they classify as follows:—

(*a*) The insanitary state of the village sites due—
  (*i*) to the thick jungle in which the houses lie embedded ;
  (*ii*) to the large number of tanks, pits and surface collections of water scattered about them;
  (*iii*) to the cultivation of rice in close proximity to the houses;
  (*iv*) to the bad drinking supply; and
  (*v*) to promiscuous defœcation.
(*b*) The water-logged state of the country.

It is to the combination of these two causes that they attribute the excessive prevalence of malaria in the areas visited. The operation of these factors again is in two directions, namely, that of directly increasing the amount of malarial infection by facilitating the breeding of mosquitoes, and of predisposing the constitutions of the local residents to attacks of malaria by weakening them in other directions. Thus the presence of jungle, by obstructing ventilation and delaying evaporation, keeps the surface of the ground damper than would otherwise be the case, and affords excellent shelter to swarms of mosquitoes; the numerous collections of pits and tanks retain the surface water and offer ideal breeding grounds, while larvæ are present in the surrounding stretches of wet rice cultivation; and in so far as the water does not drain rapidly away at the conclusion of the floods or rains by reason of obstruction to the drainage channels, these surface breeding pools continue for an undesirably lengthy period. The general filth surrounding the houses poisons the air and contaminates the water-supply, and bad drinking water, though not, as such, productive of malaria, induces bowel complaints and general debility. There is little that is new in this enumeration of causes. It can be paralleled in practically every report which has been written on the subject. Even before the tracing of the source of malarial infection to the mosquito, it was held that filthy village surroundings, the presence for long periods of slowly evaporating collections of dirty surface water, the absence of ventilation in huts located amid close jungle, and carelessness in the sources from which drinking water was brought were all prejudicial to health. The problem of the diminution of malaria is too complicated to permit of a simple recommendation for action in one direction only. The prevention of the disease is bound up with the destruction of the infected varieties of mosquitoes (either by actually killing them when bred, or by preventing their breeding by removing their breeding places); the avoidance of infection by protection from the bites of mosquitoes by the use of curtains, and the counteraction of infection by the prophylactic use of quinine and any improvement in the general health which will enable the constitution to resist attacks. In the present connection we have been asked particularly to consider how far an improvement in the drainage conditions will effect a remedy, and this solution only, therefore, will be discussed in detail, but it is complicated, difficult and expensive, and its consideration, without mention of other lines of action, is only likely to engender false impressions.

Village sanitation.

21. The matter of village sanitation really lies at the root of the whole matter. If the state of education were such that the people would keep their village sites more cleanly and more open, the conditions of health would be at once improved. The table compiled by Captain Stewart and Lieutenant Proctor showing, on the evidence of 172 villages examined, spleen rates of 68·8, 48·1 and 26·2, varying respectively according as the amount of undergrowth was thick, moderate, or little, is striking and instructive. It is noticeable how few villages among those examined in the Jessore district are classified as surrounded by little jungle, and the actual instances cited, such as those of Chakoolia, Kalinagar and Kaligachi in Jessore, Bolarampur, Jaintihazra, Radhanagar and Moheshbathan in Nadia, or Hathinagar, Rajnagar and Oosta in Murshidabad, afford strong evidence of the evil influence of the existence of dense undergrowth upon the incidence of malaria. The question of jungle cutting was mooted actively at the time of the epidemic of 1861—1864, and the action

taken to promote it was neither popular then nor is likely to be popular now, but we note that in connection with the reports submitted to us, the District Board of Murshidabad is alive to its importance, and action has been taken locally by one or two zamindars in this direction. This may be some indication of a change in popular opinion on the subject.

Water supply.

As regards the question of water supply, there is little that is new to be said. The ordinary villager is probably aware of the advantage of pure water, and will drink it for preference if it can be obtained without great trouble ; but he shows little self-help in improving the existing sources, and is often careless as to the use of that which is nearest, whatever its quality.

Destruction of mosquitoes.

Measures for the destruction of mosquitoes were first started in 1903 on a very tentative scale in Puri, but in the two succeeding years they were tried at various centres, noticeably at Berhampore. In 1906, an experiment was initiated, designed to extend over three years at a cost of Rs. 20,000, in order to test the value of such action, as also the administration of quinine, in Berhampore (Murshidabad), Ranaghat (Nadia), Moheshpur (Jessore) and Jagadispur (Shahabad). The result of the first season's working has not been altogether hopeful, but final judgment may be withheld. The difficulties are those of funds, and the methodical execution and supervision of the work. The recommendation in favour of the use of mosquito curtains made by Captain Stewart and Lieutenant Proctor is no doubt sound in theory; it it not one practically possible of adoption on a general scale.

Distribution of quinine.

The issue through post offices and the officers of the Vaccination Department of quinine in pice packets of five grains was commenced in 1892, and has been steadily pushed since. In 1903 the quantity contained in a packet was raised to seven grains, and in 1906 the village schools were utilised as distributing centres. The object in view is to bring every village within five miles of some source of supply. Figures of the consumption of quinine in the districts of the Presidency Division and of the number of centres open for its distribution are not available, but we met with evidence of the prejudice existing against its use to which reference is made by Captain Stewart and Lieutenant Proctor.

Dispensaries.

Medical assistance is at present obtainable at dispensaries of which there are 71 only in the whole division supported from public or local funds or with State aid, in addition to 8 non-aided institutions. The total is not large looking to the vast area to be covered, and we invite attention to the suggestion that selected itinerant Hospital Assistants should travel systematically in the worst affected areas during the fever season. Such a procedure has not so far been initiated, although there have been isolated deputations in special cases, but the experiment seems deserving of a trial.

DISTRICT.	Number of dispensaries.
Jessore	12
Nadia	12
Murshidabad ...	5
Khulna	14
24-Parganas ...	28
Total ...	71

Drainage.

There remains the remedy of drainage, with which we are mainly in the present instance concerned.

[illegible]

[illegible]

CHAPTER IV.

THE DRAINAGE SYSTEM OF THE PRESIDENCY DIVISION AND THE QUESTION OF ITS IMPROVEMENT.

Rice cultivation and drainage.

22. At the threshold of any scheme for the improvement of the drainage conditions in the Presidency Division stands the question of the cultivation of rice. The following are the figures with which we have been supplied by the Director of Agriculture showing the normal areas in each district (*a*) under rice, and (*b*) under all other crops; they are, of course, approximate only:—

District.	Normal area under rice.			Normal area under all other crops.	Percentage of total cropped area under			
	Winter rice.	Autumn rice.	Summer rice.		Winter rice.	Autumn rice.	Summer rice.	Rice of all kinds.
	Acres.	Acres.	Acres.	Acres.				
Jessore	583,600	371,900	2,500	477,500	40·6	25·9	·2	66·7
Nadia	136,800	328,900	400	547,000	13·5	32·4	·03	45·9
Murshidabad	277,100	229,700	1,200	655,400	23·8	19·7	·1	43·6
Khulna	655,700	45,800	85,800	129,100	71·5	4·9	9·4	85·9
24-Parganas	903,300	74,600	4,000	164,800	78·7	6·5	·3	85·6
Whole Division	2,556,500	1,050,900	93 900	1,973,800	45·0	18·5	1·6	65·2

It is the winter rice which demands the retention of water upon the land at a time when, from the point of view of malarial prevention, it is desirable that the ground should be drying rapidly, *i.e.*, up till about the middle of November, and it is obvious that while so large a proportion as 45 per cent. of the total normal cropped area in the division is under winter rice (varying from 13·5 per cent. in Nadia to 78·7 per cent. in the 24-Parganas), malaria is bound to prevail to a large extent. The malaria bearing varieties of anopheles mosquitoes are known to breed in rice fields among other places, and so long as rice cultivation is in close proximity to the village sites, the inhabitants will suffer from the infection conveyed by them. On the other hand the remedy suggested by Captain Stewart and Lieutenant Proctor that rice cultivation should not be permitted in the neighbourhood of villages is not a practicable one in the present state of public opinion. The village huts in Bengal are not even, as a rule, concentrated in one locality, and it is not quite clear what is intended by the substitution of dry crops for rice, since it does not follow that rice soils are always capable of growing any thing else. There seems no present practical alternative but to accept the situation.

The tidal level and its effect on drainage.

23. The second obvious limitation to the success of any drainage scheme is the small elevation of the Presidency Division above sea level. So long as the difference of level is so slight, and the annual average rainfall in the division is about 63* inches, it is impossible that any scheme of drainage, however comprehensive, which has to provide for the requirements of rice cultivation, can be so effective as to obviate the water-logging which must at certain times of the year be characteristic of the locality. A well designed drainage work may shorten the period which the country takes to dry, and in so far may be extremely beneficial. It cannot eliminate the wet period entirely. We have no wish to urge these well-known facts as sufficient reasons for regarding all attempts at drainage as futile. We hold no such view, but it is as well to state exactly the difficulties attaching to the case.

The terms "drainage" and "obstructed drainage."

24. In one of the earliest papers dealing with malaria in Bengal (the report of the Epidemic Commission, 1864), a description of the general system of village drainage in Bengal was given by Babu Digambar Mitter which has usually been accepted since as a generally accurate account of what would occur did no obstruction exist. He wrote as follows:—

> "The drainage of all the villages * * * * in Lower Bengal is effected by the water first running into the nearest paddy-fields lying in the direction of their slope, thence it collects in the bheels, from which it rushes through khals into larger streams, which again communicate with navigable rivers."

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* Figures of ten years 1896—1905.

Rural drainage, in this view (and we do not understand that our reference is concerned with urban drainage, which is already the particular province of the Sanitary Engineer) may be considered in four stages, namely, (*a*) in the village sites themselves, (*b*) in the rice fields, (*c*) in the bheels, and (*d*) in the khals communicating from them to the rivers and in the river channels themselves. Similarly, obstructions to the free flow of drainage may be caused by—

(*a*) pits and holes, raised paths, and jungle-choked channels which cause the water to accumulate in the village itself;

(*b*) by measures intentionally taken in order to retain the water up to a certain time upon the rice fields by the means of small banks; or

(*c*) by obstacles lying in the channels which should drain the bheels or in the rivers into which these channels ultimately fall. These may either be artificial, usually fishing weirs, embankments impounding water, tanks dug in the bed of the nalas, or roads, railways and protective embankments crossing them; or natural, *i.e.*, accumulations of silt deposited by the water which enters the khals or rivers in times of flood.

Determination of the areas of obstructed drainage.

25. The question to which it is desired that the present enquiry should afford an answer is whether in the areas which we have defined as malarious, it is possible to point to any existing obstructions to the drainage; is the malaria attributable to such obstructions; and if so, is it possible to remove them? To the first query we are unable to offer a complete detailed reply. It is known that obstructions of the class which we have described as characteristic of the village site itself are common to practically every village in the division, and we have given figures showing the extent to which the cultivation of rice is carried on. So far, the answer is simple, but to specify exactly where obstructions are to be found in the khals and rivers through which the drainage once flowed requires a detailed examination of the local circumstances, which has never hitherto been made, and which it would take time to accomplish. We are strongly of opinion that such an enquiry is required. We will refer below to the information which the local officers have been able to give us with reference to the state of the drainage channels in their districts, but except where definite remedial schemes have taken shape and are under discussion, the data are for the most part vague. There are many general allegations that this area is water-logged or that that channel has deteriorated, but there are few facts on record showing when or how this occurred, to what extent the change has gone on, or as to the levels of the tract or the volume of water to be dealt with. The suggestion that the drainage conditions of the country should be studied in detail is not new. Subsequent to the epidemic of 1861—1864 the Lieutenant-Governor observed that he attached the highest importance to the preparation of a comprehensive scheme of drainage for the districts attacked by the epidemic, and requested sanction to a special appointment for the purpose; but while the Government of India acceded to an enquiry into the alleged obstruction to drainage from roads and embankments, which was then attracting considerable attention, they "did not see that there would be any advantage in having, at the present moment, a more extended survey of the drainage conditions of Bengal. The subject is too large to be satisfactorily disposed of by the deputation of a single officer; it is the duty of the District Officers and District Engineers to keep their eye upon the general drainage of the country, and to watch when it is defective, and from time to time to suggest plans for remedying what is wrong." Unfortunately, however, this has never subsequently been done methodically by the district staffs, and it is doubtful if they have the time to do so. They can supply information of a general nature, but little detail; even the general facts have never been regularly placed on record. An exception is to be found in the Hooghly district in which, in the course of the Burdwan epidemic of 1869—1874 and subequently, detailed enquiries as to

Letter from the Government of Bengal, to the Government of India, No. 286, dated the 16th January 1868.

Letter of the Government of India, No. 867, dated the 21st February 1868.

the course of local drainage were made, and from them resulted the Eden Canal, and the projects for the drainage of the Dhankuni, Rajapur and Howrah bheels. Similarly, in connection with the enquiries touching the embankments in the southern portion of the 24-Parganas, the drainage levels of a large tract of country have been worked out, and the Magrahat drainage scheme has been undertaken, while in the course of our recent enquiries it has been possible to furnish us with definite facts showing the position and extent of the different basins, and the sufficiency or otherwise of the facilities for drainage in them. But these instances are few, and we think it most desirable that systematic action should be initiated for the collection of information regarding the drainage levels of malarious areas. It was remarked in the Sanitary Report of 1868 that "the history of Bengal, in a sanitary point of view, is the history of its rivers and water courses," and we would advocate the maintenance of regular gauge readings and notes as to the condition of these channels from year to year. Gauge readings at present are only maintained in respect of the Bhagirathi, Jalangi and Mathabhanga rivers. In the expense of such river records we consider that District Boards might share, the remarks being particularly applicable to the Jessore and Khulna districts. Apart from considerations of health, the rivers are the great means of communication, and the District Boards are interested in their efficient maintenance. The expense of preliminary drainage surveys we consider that Government should accept as a contribution towards the general welfare of the country. It is to the interest of Government that the exact facts should be known, and much vague statement thereby avoided. We have already advocated further enquiry into the local medical conditions. Were the facts as regards drainage equally well known, it would be possible for the District Officer to explain the situation clearly to the local residents and to seek their co-operation in a remedy. The proposition which in fact he could lay before them would run somewhat as follows: these are the facts as to health; these are the facts as to drainage; this is a possible scheme for the improvement of the drainage from which a reduction of the present mortality from malaria may be anticipated; and this is the estimated cost of it; is co-operation forthcoming? It is true as remarked by the Government of India in 1868 that the task is a large one, but this is scarcely justification for its abandonment. Also it is possible, if not probable, that in many cases the people concerned will not join in a remedy, but they will, at any rate, have had the opportunity of doing so, the facts will be known, and if they prefer the consequences of their own refusal, they must accept them. In connection with a closely analogous proposal for the preparation of possible schemes of irrigation (and drainage in the districts of the delta may be said to take the place of irrigation elsewhere), we understand that sanction has already been sought to the creation of two Investigating Divisions of the strength noted in the margin at an annual cost of Rs. 18,120 each. We propose that one of these divisions should be concerned with schemes of drainage. The object in view would be the examination of the existing conditions of areas known to be malarious, ascertaining where (if at all) the drainage is at present obstructed, and how it could be remedied, outlining roughly definite projects at an estimated cost affecting defined areas. It is not necessary, or desirable perhaps, that large schemes only should be considered; small works in fact may be more practicable. It would rest with the District Officer, after he was in possession of the facts, to endeavour to secure the execution of the scheme under one or other of the laws applicable.

	Rs.
1 Executive Engineer (3rd grade with travelling allowance) ...	800
1 Supervisor (ditto) ...	250
1 Overseer (ditto) ...	135
1 Sub-overseer (ditto) ...	75
1 Clerk and cashier ...	50
1 Draftsman	50
6 Peons, with travelling allowance	50
Contingencies	100
Total ...	1,510

Obstruction to village drainage.

26. Were action taken in this direction it would at least be possible to state exactly where obstructions to drainage existed. To the question whether malaria is attributable to such obstructions we can only reply that in so far as they result in, or prolong, the existence of breeding places for mosquitoes, and induce a general dampness of the soil which is prejudicial to health, they favour the propagation of malaria, and we proceed to discuss the effect in this direction

of obstructions to drainage of the three descriptions already enumerated, namely, in the village sites, the bheels, and in the khals and rivers. In so doing we will note the facts, so far as they are available, as to the extent of such obstructions, and will consider the feasibility and desirability of a remedy in each case.

The existence of pits, hollows and pools amid the village huts in which filthy water gathers, and the blocking of side drains by jungle and occasionally by raised paths, as already stated, are common to villages everywhere, and to them must be given the first place in the causation of malaria. Obstructed drainage of this class brings the breeding grounds of mosquitoes into the closest proximity to the dwelling places, and, while their range of flight is now known to be longer than was at one time thought, these insects will not fly far if breeding places are ready to hand adjacent to the persons upon whose blood they feed. The whole question of a remedy is bound up with the larger issue of the practicability in the present state of public opinion of constituting any local authority with powers of supervision over the sanitation of a small area, and with funds from which minor works can be carried out. The nucleus of such bodies perhaps exists either in the union committees constituted under section 38 of the Local Self-Government Act, or in the panchayats under the Chaukidari Act, but hitherto the influence so exercised in respect of sanitation has been slight, and inevitably so, so long as the people themselves have no keen interest in the matter. The apathy existing on the subject in the Presidency Division is commented upon in the recent Resolution of Government upon the working of Local Self-Government during 1905-06. The enforcement of sanitation means regulation, and it is doubtful whether such rules would prove welcome in the present state of rural opinion. Looking at the fact that many municipalities are merely large villages, it is not hopeful for the progress of rural sanitation that out of 46 municipalities in the Presidency Division, 31 are taking no action towards the preparation of drainage schemes, and 12 only have schemes in course of incubation. Three schemes have been finally approved, but not yet completed. Yet municipalities have both an agency on the spot and the means of raising funds for such purposes. We do not dwell upon this point at greater length since the question involved is rather that of agency and finance than of the practicability of drainage schemes, with which we are particularly concerned, but that the improvement of the village sites is the primary essential in the prevention of malaria we consider to be undoubted, and the practical demonstration of this fact by action taken in a selected area might have a valuable effect upon public opinion. It would be worth the while of Government to afford such an object lesson.

Obstruction to drainage in bheels.

27. Turning to the effect upon the health of villages of bheels in their proximity, local officers have furnished us, in the course of our present enquiries, with statements of the principal bheels in the division, numbering 140 in all, and covering a total area of some 526 square miles. The figures are not more than a very general approximation, since the local classification of "principal" bheels would seem to have varied, and for our present purpose there would be no advantage in a reproduction of the list of names.* It is also necessary to differentiate between bheels which are more in the nature of lakes of deep, clear water and well defined limits, and those which may be described as marshes, but of either class we have few details. The former may be natural drainage basins, the level of which does not permit of drainage; the latter are accumulations of water upon low-lying ground, much of which could be got rid of were there open channels connecting them with the rivers. We have received various reports, more or less general in character, that the old drainage channels leading from specific bheels have been impeded, but, as a whole, the information is absolutely incomplete, and it would be entirely misleading to

DISTRICT.	No. of bheels.	Total area. Square miles.
Jessore	15	98
Nadia	67	26
Murshidabad	25	51
Khulna	24	292
24-Parganas	9	59
Total ...	140	526

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* The detailed statements, supported by maps showing the position of the bheels, have been recorded in the office of the Chief Engineer, and may possibly be of use in subsequent enquiries.

offer it as a statement indicative of the needs of the division in the matter of the drainage of bheels. This can only be ascertained by a detailed enquiry, such as we have already advocated. All that can now be said is that large areas are covered by bheel land, some of which can never be drained so far as it is below tide level, but much of which, as a matter of engineering, could be drained and improved by re-opening the channels connecting with the rivers, which have either silted up or have been artificially obstructed, or by the construction of new outfall channels. It is similarly equally impossible, in the division as a whole, on the basis of any information at present on record, to assert a connection between the unhealthiness of particular areas and the presence of particular bheels, and we are, therefore, reduced to a treatment of the point upon somewhat general lines.

It cannot be said that bheels which approximate to lakes are probably detrimental to health. They never dry up leaving large areas of shallow mosquito-breeding pools, and they may be useful reservoirs of drinking water. The charge is rather against the swamp, which has either never been drained, or which at one time used to drain more quickly than it does at present. The influence of such a bheel upon the prevalence of malaria may be exercised in two ways, either as itself affording a breeding ground for mosquitoes which is more extensive, and probably, therefore, also brought into closer proximity to the houses of the village than it need be were the drainage efficient, or as an obstacle to the prompt fall of the water level in the adjacent country. If the water level in the bheel, by efficient drainage, fell quickly, the surrounding country draining into the bheel would dry more rapidly; hence collections of surface water would be found existing for shorter periods, and fewer facilities would be offered for the breeding of mosquitoes. In this, we assume a fair percolation from the surrounding country, although there are some soils met with in the delta which are practically water-tight. In such cases the surface water only would be affected. The general connection between the prevalence of malaria and the height of the subsoil water is deserving of further investigation than it has as yet received in Bengal. Captain Stewart and Lieutenant Proctor have endeavoured to collect some data, but we do not consider that great importance can be attached to them. They were necessarily not based upon accurate and regular observation, and in so far as they would tend to show the average level of the subsoil water as highest in Murshidabad, and higher in Nadia than in Jessore, they would appear to be misleading. An endeavour to collect similar information from the District Officers has not produced figures which we consider can be relied upon, and it might well be prescribed as the duty of some competent observer to record these levels at typical centres, *e.g.*, wherever there was a dispensary at which statistics of the cases of malaria treated at different times during the year could be compiled. However, there can be no doubt as to the intense dampness of the soil of the delta during, and at the close of, the rains, and anything which would expedite the process of drying cannot fail to be beneficial to health generally. The opinion of Captain Stewart and Lieutenant Proctor is that "the draining of bheels is likely to do good if the water can be got off the land as early as possible after the rains; if it is to be kept on the land artificially for the purposes of rice cultivation until the middle of November, and then drained off, the greater part of the good will be lost. Nearly all the fresh infections of malaria occur before that time, and the damage has already been done." And again "the drainage of bheels will probably do good, but to what extent it can only be ascertained by experiment." We are of opinion that the case might have been put rather more strongly than has here been done. The object in view is to get the country dry as speedily as possible, and a badly drained bheel must be an obstacle to so doing. The benefits likely to accrue from the reclamation of land for cultivation are obvious. Where such schemes have been carried out, the evidence, so far as it goes, is favourable. We admit that it might be more explicit, but the fact that it is not so is due largely to the unreliability of the earlier statistics of mortality and to the absence of a detailed examination of the tract prior to its drainage. Orders have recently been passed (Government Order No. 342T.M., dated the 3rd May 1906) which, in future, will remedy this defect. The leading cases which we have as precedents are those of the

Dhankuni bheel in Hooghly, drained in 1873, the Howrah bheel near Howrah, drained in 1887, and the adjacent Rajapur project which was completed in 1891. It is to be noted that these works were undertaken largely in the interests of land reclamation, and in the annual report of the Sanitary Commissioner for 1879, it was observed as regards the Dhankuni project that "with regard to the fever we are in doubt as to the directly beneficial effect the scheme has had on the health of the people, though of its success as a drainage scheme and of the swamps having been converted into a highly cultivated area, there can be no doubt. There has been an improvement in health everywhere, and an examination of Mr. Adley's report shows that there was no extraordinary sickness in or around this jheel in 1867 to 1869." This is not very helpful, but the District Magistrate of Hooghly has furnished us with average figures for the last 16 years (1890 to 1906) comparing the mortality in the Chanditola and Singhur thanas, which are affected by the scheme, and in the adjacent thanas which are not, and these certainly show some advantage in favour of the former. For want of early records we cannot, of course, say whether these two thanas were not more healthy than the rest, even before the execution of the scheme. As regards the Howrah work, it affects 61 villages in thana Domjur, and all that can be said is that in that area deaths from fever have in recent times shown a tendency to decline. In the 24-Parganas the Bullee bheel was drained in 1882, and the Cherial bheel in 1887. Unfortunately the District Magistrate can give no data proving or disproving any beneficial result from the point of view of health.

THANA.	Average annual death rate per mille.	
	1890—99.	1900—06.
Serampore municipality ...	48·2	35·2
Ditto thana ...	32·7	31·8
Uttarpara	39·9	33·4
Katarang	42·5	35·4
Baidyabati	32·6	31·5
Bhadreswar	52·0	40·1
Haripal	32·1	34·6
Kristanagar	34·8	37·2
Chanditola	29·7	29·3
Singhur	30·2	30·2

YEAR.	Deaths from fever in thana Domjur.
1897	1,091
1898	1,876
1899	2,932
1900	1,762
1901	1,621
1902	1,665
1903	1,545
1904	1,088
1905	1,395
1906	934

In their recent enquiries Captain Stewart and Lieutenant Proctor have endeavoured to arrive at some conclusions as to the effect of situation upon the health of villages, and the following abstract of their results is exceedingly interesting:—

SITUATION.	Number of villages examined.	Average spleen rates.
On dry land	45	45·6
On live rivers	33	46·0
On bheels	56	62·2
On dead rivers	38	64·5

The effect upon health of a river situation will be discussed later. In the report upon the Jessore district a sub-classification was made between such bheels as had a connection with a river, that is, were liable to be flushed, and such as had not, *i.e.*, were stagnant collections of rain water and surface drainage. The results are noted in the margin, and, so far as they go, they point to the greater healthiness of the former state of affairs, but the numbers of villages in the second class examined is too small to permit of a general deduction. Moreover, the term "flushed" is to some extent misleading, as while water may enter the bheel from the river in flood, it can scarcely be in sufficient volume to scour out the bheel. We therefore disregard this distinction. The rates obtained in the

SITUATION.	Number of villages examined.	Average spleen rate.
On flushed bheels ...	36	66·0
On unflushed bheels ...	7	79·4

case of villages on bheels in the individual districts visited are reproduced in the margin, and are at once open to the criticism that the basis of generalisation is narrow, noticeably so outside the Jessore district, but this merely corroborates the need of further enquiry. Thus, as an instance, the rate of 49 in Murshidabad is reported to be almost certainly too low, due to 3 villages of inexplicable healthiness; 80 is suggested as a more accurate rate. Apart from these three villages and four in Jessore (with spleen rates of 7, 16, 17 and 18) there are no villages upon bheels which show low rates, and, while it is true, as pointed out by Captain Stewart and Lieutenant Proctor, that the class, as a whole, shows curious variations from 6 to 91, this must be qualified by the remark that the proportion of healthy villages is small. These variations within the class are common to all; they are sometimes difficult to explain, and are a good example of the numerous factors complicating the question. But upon the evidence we think that it may fairly be said that villages upon bheels are of a degree of unhealthiness only exceeded by those on dead rivers, and that some portion of this additional unhealthiness must be attributed to the presence of the bheel. Any action therefore towards draining the bheel should be productive of good. As engineering works there are many such schemes which are feasible. The difficulty lies in the diversity of interests which their execution involves, which in the past has led to the abandonment of projects even where they had been worked out. For instance projects for the drainage of the Burthee and Dhokra bheels in the 24-Parganas were elaborated, but were dropped in 1885-86 owing to the impossibility of arriving at agreement. We do not admit that the futility of enquiring into such schemes is thereby demonstrated, since we consider it in every way desirable that the fact should be known to those locally interested, but popular opposition towards contributions to any scheme which has for its chief object the improvement of health must be reckoned on, and even the advantage of land reclamation will not always willingly be paid for. Some assistance might desirably be offered on the part of Government, as has recently been done in the case of the Magrahat scheme, in order to give some encouragement to local effort. The proportion of such aid to the total cost of the project can only be determined upon the merits in each case.

DISTRICT.		Number of villages visited.	Average spleen rate.
Jessore	...	43	7·27
Nadia (Kumarkhali and Jibannagar thanas)	...	6	65
Nadia (Gangni thana)	...	3	76
Murshidabad	...	7	49

Obstruction to drainage in khals and river channels.

28. With regard to obstructions in khals and river channels, the information which we can give is more exact than in the case of bheels, but even here we can scarcely offer it as complete. In speaking of an obstructed channel, it is necessary to define carefully what is meant. A channel is obstructed in the usual sense if it is blocked up by silt bars or tanks and embankments in its bed preventing the free flow of the water : such are the Gobra nala in Murshidabad, and the Nawai and Soonti rivers in the 24-Parganas. But there may also be a stagnation or absence of flow in a channel for the reason that little or no water is coming into it either at its head or from the tributaries draining into its course; such an instance is that of the Bhairab, above Jessore town. Both cases are loosely spoken of as obstructed drainage, but they differ essentially in their nature. If the channels of the Nawai and Soonti were cleared, they would carry off the water which at present at places is penned up in them ; nothing would result from clearing the channel of the Bhairab so long as its head and the communications with the side khals remain as they are. The channel is amply big enough to carry off all the drainage which comes into it at present; in fact it is far too large. What is meant in such a case by the advocates of a remedy for the alleged obstructed drainage is that the head of the channel, if possible, should be opened up so as to introduce more water into it. This is scarcely drainage at all; if anything, it is flushing or the causation of a flow of water. It does not lower the sub-soil level of the water in the drainage basins served by the channels, but introduces more water into them. It is this remedy, which apparently numbers most supporters among public opinion, although the vaguest notions exist as to its practicability, and we accordingly deal with it in some detail.

With regard to the existence of what we class as true obstructions in the courses of rivers and khals, our position is similar to that noticed in the case of the drainage of bheels. It is known that many channels are thus impeded, and instances have been brought to our notice in the course of our tours, but short of a detailed examination of the division, it is impossible to offer any statement of such cases which is in any way complete, much less to allege a connection between local health and any particular obstruction of the kind. As regards the practical question of a remedy it may be said generally that, given the necessary funds, there is no doubt that obstructions of this class can be removed, and there can be little doubt as to the desirability of so doing.

The river system of the Presidency Division.

29. In order to appreciate the position as regards the so-called obstructed rivers in which the flow of water is small by reason of the fact that no water is coming into them at their heads, it is necessary to glance briefly at the general river[*] system of the western portion of the Ganges delta, and the map which we attach as a frontispiece to this report may facilitate a comprehension of the facts.

The portion of the delta with which we are now concerned is bounded on the north by the Ganges or Padma river, on the south by the Bay of Bengal, on the west by the Bhagirathi river, and on the east by the Madhumati river. The Bhagirathi is the first stream on the west which takes off from the Ganges towards the sea, and proceeding eastwards we have the Jalangi which unites with the Bhagirathi to form the Hooghly at Nadia; the Mathabhanga which falls into the Hooghly to the south-west of Ranaghat; and the Gorai which, taking off from the Ganges at Kushtia at the eastern limit of the tract under consideration, becomes the Madhumati, and makes its way to the sea as the Haringhatta. These four channels constitute the main arteries traversing the whole tract from north to south through which so much of the water of the Ganges flows as does not proceed down the Padma towards Goalundo. Between these arteries are various distributary streams running generally from north-west to south-east (although the direction is now the reverse on the eastern side of the Jessore district), but in some cases tending in a more southerly direction, and falling through a net-work of channels by independent mouths into the Bay of Bengal. It is through these connecting links that the water of the Ganges, spreading over the delta, has already raised it, or is in course of so doing. The process on the western side is now more or less an accomplished fact; on the east it is in progress, and in the centre it is gradually ceasing. Consequently, on the western side there are few of these cross streams which can still be characterised as rivers, and in the area enclosed by the Bhagirathi on the west and the Mathabhanga on the east, the reaches of the Upper Bhairub alone survive, and this too is rapidly losing the character of a river and approximating to the old nalas and khals with which the tract is seamed, remnants of old channels which have now disappeared. It is between the Mathabhanga on the west and the Madhumati on the east that the area *par excellence* of decaying rivers lies. Here the rivers Kumar, Noboganga, Lower Bhairab[†] and Ichamatti still remain as offshoots from the Mathabhanga towards the south-east, until (with the exception of the Ichamatti) they encounter in their lower reaches the waters of the Gorai and Madhumati, which, coming by various cross channels of communication from the north-east, give a general southward and south-westward trend to the river currents. Between the Kumar, Noboganga and Bhairab lie a net-work of connecting streams of which the best known are the Chitra, Beng, Katki, Kabadak, Harihar and Bhadra.

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[*] In the following brief account of the Ganges delta, we have relied upon the following publications:

Rennell's Account of the Ganges and Burrampooter rivers, January 1781. Philosophical Transactions of the Royal Society of London, Volume LXXI.

Colebrooke's Report on the Course of the Ganges through Bengal. Transactions of the Asiatic Society, Volume VII, 1801.

Report by Captain Lang on the Nadia Rivers, dated the 14th July 1848, Bengal Selections, No. II.

Report by Major Lang on Direct Water Communication between the Ganges and Calcutta, dated the 7th April 1854, Bengal Selections, No. XIX.

Report on the Rivers of Bengal by Captain Sherwill, dated the 19th February 1857, Bengal Selections, No. XXIX.

Memorandum by Colonel Cotton on Water Communication between Calcutta and Rajmahal, dated the 31st July 1858.

Mr. J. Fergusson on Changes in the delta of the Ganges, 1863. Quarterly Journal of the Geological Society of London, Volume XIX.

Mr. Westland's Manual of the Jessore district, 1870.

Bengal Provincial Census Report, 1901.

[†] Mr. Westland in his Manual of the Jessore district speaks of the Kabadak as emerging from the Matabhanga and the Bhairab from the Kabadak. We prefer the present description. The Bhairab can still be traced in its upper reaches in Nadia and Murshidabad, and is clearly the more important river of the two.

The general progress of the Ganges eastward.

30. It is evident therefore that the life of these cross streams is bound up with what we have described as the main arteries; if the latter decay, their offshoots must suffer similarly. But the whole history of the delta has been one of the gradual progress of the Ganges eastwards. When the main river, probably in the 16th century, quitting the Bhagirathi, down which it had hitherto flowed, once started eastwards, it may, in time, as surmised in the census report of 1901, have successively found its main outlet through the channels of the Jalangi, Matabhanga, Kumar or Nobogunga, and Gorai, but its advance was continually further east, leaving the offtakes to the west to dwindle and decay. In the early part of the last century a reflex action set in between the years 1810 and 1830. The waters of the Brahmaputra, which had formerly flowed east of the Madhupur jungle, were diverted to the west, and encountering the stream of the Ganges threatened to push it back through its old distributaries to the west. This process was not accomplished fully, but the result was the enlargement of the Gorai, the creation of the Madhumati (previously an insignificant khal), and the diversion of the flow of drainage on the eastern side of the Jessore district from south-east to south and south-west, as already mentioned. With this one exception, however, the statement as to the easterly progress of the Ganges holds good, and while this exception did result in a further accession of water to the western distributaries in their lower reaches, it is significant that this was brought about by no artificial means, but by a natural change in the course of so mighty an agent as the Brahmaputra, impossible of accomplishment by human agency.

The history of the Nadia rivers.

31. The result of this advance of the main stream eastwards was, as mentioned, the diminution in bulk of the rivers taking off from it on the south, and there is good evidence that this was brought about in no recent times. The earliest mention of the facts traceable is that by Tavernier in 1666 to the effect that the mouth of the Bhagirathi was closed by a sand bank in January; but Holwell in 1756, proceeding to Murshidabad, was detained by shallows at Santipur which is below the junction of the Bhagirathi and Jalangi. Rennell in 1781 wrote that "the Cossimbazar river" (*i.e.*, the Bhagirathi) "is almost dry from October to May, and the Jalangi river (although a stream runs in it the whole year) is in some years unnavigable during two or three of the driest months; while Colebrooke in 1801 stated that the Gorai and Chandni were the only channels navigable throughout the dry season, and that the Bhagirathi and Jalangi could not be relied upon. In 1820 on the Mathabhanga, and in 1824 on the Bhagirathi and Jalangi, regular measures were undertaken with the view of maintaining open channels for navigation, and these have continued till the present day, though with only moderate success. The end in view is the maintenance of a channel suitable for boats of small draft, and the main means employed are the erection of temporary bamboo training works. Recently dredging has been tried, but it is as yet too early to forecast the result. The most important modern change in the channel of the Jalangi was the silting up of the upper part of its course for some 36 miles; it now derives its water through the Upper Bhairab and another channel known as the Shealmari.

Changes in the Jessore rivers.

32. We therefore have the fact that from natural courses, dating from two or three centuries at least, the trend of the Ganges eastwards has diminished the efficiency of the four rivers taking off from it to the south with which we are now concerned, namely, the Bhagirathi, Jalangi, Mathabhanga and Gorai, although the volume of the last-named stream was replenished in the early part of the nineteenth century by the action of the waters of the Brahmaputra upon those of the Ganges. The deterioration of the distributaries dependent upon these four rivers was the natural consequence, and this

too must have been in progress for many years. We note below the main facts regarding the principal streams referred to, following for the most part the account given by Mr. Westland, supplemented by such information as, short of a detailed survey, we have been able to gather in the course of our recent enquiries:—

The Upper Bhairab.—No accurate history of this river appears to be known. It was certainly an important river once, and it has been surmised that it was the southern continuation of the Mahananda which was cut in half by the Padma during the advance of the latter east. It must have been reduced to its present condition many years ago. Its connection with the Ganges entirely closed up at one time, but re-opened in 1874, and now constitutes the real offtake of the waters of the Jalangi. If this actual offtake from the Ganges be now considered as that of the Jalangi, the Upper Bhairab may be said formerly to have left that river near Karimpur, but this mouth is now entirely silted up for a length of some eight miles. The channel is now little better than a series of pools traversing the Meherpur subdivision.

The Kumar.—As late as 1820 five-sixths of the water of the Mathabhanga made their way down the Kumar, and between that year and 1828 various attempts were made in the interests of the Mathabhanga to cause its waters to quit this channel and a second offtake through the Pangasi, both by placing barriers across the mouth of the Kumar and by cuts in the course of the Mathabhanga. They were not successful, but the mouth of the Kumar was noted in 1870 as obstructed by silt in the hot weather. The offtake at Boalia is still open, but there is little flow of water, about 1½ feet at the end of the cold weather. It is now said to be navigable throughout for large boats in the rains only, whereas Mr. Westland stated that it was so all the year round. It is presumed, therefore, to have deteriorated within recent years. In its lower reaches it used to receive water from the Gorai through the Kaliganga. This too has now silted up.

The Noboganga.—The old offtake of the Noboganga from the Mathabhanga near Damurhuda was entirely silted up for about six miles (reported to us recently as four miles) when Mr. Westland wrote, and there seems to have been little change since, though it is said generally to have deteriorated.

The Lower Bhairab.—The river is now much as Mr. Westland described it. Its connection with the Mathabhanga near Jaynagar is entirely silted up for about 2½ miles, but there is the same authority for the statement that obstructions to the Bhairab date back to at least 1794. The final disconnection of the river from the Mathabhanga may be said approximately to have occurred in the year 1830. Between Jaynagar and Basuntia (below Jessore) it is little better than a marsh in the hot weather and a slowly-flowing khal in the rains.

The Ichamatti.—The Ichamatti is not a dead river, and has still a fair flow at its offtake from the Mathabhanga.

Chitra, Beng, Katki, Kabadak, Harihar and Bhadra.

With regard to the minor streams noted in the margin we have been unable to collect any more accurate information than is given by Mr. Westland, beyond mention of a small change in the lower reaches of the Chitra. These streams have not probably undergone great changes since. The heads of the Chitra, Kabadak, Harihar and Bhadra are all mentioned by Mr. Westland as having been completely closed. The Katki and Beng are now reported by the District Magistrate, Jessore, to be practically dry during the cold weather. A note written by the District Engineer, Jessore, in 1904 surmises that the deterioration of the Beng, Katki, Harihar and Bhadra has been in progress since some two centuries; of the Chitra since about a hundred years ago, and of the Kabadak since about 1830.

Changes in the Gorai river.

33. The important change which, since about the year 1903, has taken place at the Ganges offtake of the Gorai river is indicated in red lines on the accompanying map, and is most instructive as illustrating the wide limits within which the main Ganges channel is liable to shift, as also the liability of experienced observers to err in forecasting the probable movements of the river. It was remarked by Captain Sherwill in 1857 that "the Gorai is becoming broader every year; its fierce current is cutting rapidly away its banks, and in a few years it will likely

absorb the greater portion, if not all, of the water from the Poddah." Again Mr. Fergusson in 1863 considered that there was a good chance that the action of the Brahmaputra, already described, would send the Ganges down the Gorai, the Upper Kumar (*i.e.*, Matabhanga) and the Chandna (east of the Gorai). No one then imagined the deterioration of the Gorai, but we now find an extensive movement of the Ganges northwards, leaving Kushtia separated by some 6 or 8 miles of sand from the main channel which formerly flowed below it, and seriously affecting the current in the Gorai. The channel known as the Hanu is reported to have deteriorated greatly within the last 30 years.

The possibility of opening up rivers silted at the head.

34. We have now mentioned briefly the more important cases in which rivers in the Presidency Division have decayed by reason of the formation of silt obstructions at their offtakes from some larger streams, and it is possible to gauge the merits of the suggestion that communication should be restored between them and the once parent rivers. The stages entailed are the following:—

(*a*) The diversion of a larger quantity of the Ganges water than at present down the main rivers taking off from it direct, of which the most important in this connection is the Matabhanga.

(*b*) The re-excavation for distances of two or three miles of the heads of the smaller rivers, *e.g.*, the Bhairab, which take off from these main arteries.

(*c*) Similar re-excavation of the heads of the still smaller cross streams, *e.g.*, the Chitra, which take off again in their turn from these intermediate rivers.

Unless the first stage is feasible, the second is of little use; and similarly the third depends upon the second. The question of controlling the main waters of the Ganges was perhaps discussed in greater detail about the middle of last century than subsequently, and with the exception of Colonel Cotton, who was prepared to erect an anicut across the main stream, but who failed to convince the authorities of the time, we have been unable to trace much opinion in its favour. Major Lang's report of 1854 thus summarises the prevailing view:—

> "Mr. May, who superintended measures for their improvement during a period of twenty years, felt convinced that the extraordinary deviations in the Ganges, affecting as they did all the streams which flow from it, rendered it impossible to lay down any fixed rule or plan by which the Nadia rivers could be made permanently navigable.
>
> "Major Shalch, who, in 1821, gave much attention to the subject, was satisfied of the inutility of attempting to form any uninterrupted communication between the Ganges and Calcutta through either of these rivers * * * *
>
> "The Rajmahal Canal Committee, appointed in 1831, consisting of Colonel Macleod, Chief Engineer, Colonel Forbes, R.E., and Mr. May observed in their report: 'We are not aware of any mode by which the impediments which annually present themselves to the free navigation of the Nadia rivers can be permanently overcome or guarded against, experience having proved that the changes which take place in the course of the great river in one season (necessarily more or less influencing the navigation of all rivers branching from it) afford no data to determine what the next may produce.' * * * *
>
> "Major Smith, R.E., succeeded Mr. May, and after seven years' supervision, came to the same conclusion that the maintenance of a permanent navigable channel by one of the Nadia rivers was hopeless. My own opinion, which was formed to a great extent on the recorded experience of my predecessors, has been strengthened from year to year by what has fallen under my own observation."

Major Lang's own opinion, as given in his report of 1848, was to the effect "that these ever-recurring variations in the course of the Ganges, and consequent changes in the position of the heads of the streams branching from it, being considered, the impossibility of maintaining a durable communication between the Ganges and Calcutta by one of the Nadia rivers must, I think, be admitted." Captain Sherwill in 1857 recommended further enquiry, but surmised that "from all I have seen of the river, I feel inclined to predict that the Bhagirathi, by the inevitable law of natural operations, is doomed to be a dreary bed of dry sand for nine months in the year." The whole drift of Mr. Fergusson's paper was to establish that rivers oscillated according to definite natural laws against which it was useless to contend. The observations of this time were of course concerned principally with the improvement of navigation, but the depth of water which would be required in order to guarantee an elaborate system of distribution through subsidiary channels now closed, would be considerably greater than that necessary to permit of country boats ascending the main stream. Latterly there have been few such detailed enquiries. The office of the Superintending Engineer maintains a plan showing the river entrances since 1822 (in the case of the Bhagirathi, Jalangi and Mathabhanga), and weekly gauge readings are taken at various points. We think that more detailed information might usefully be placed on record each year. The difficulties which have always been felt in seeking to control the stream of the Ganges are due to the bulk of water in the channel and the extraordinary movements of the current from side to side, affecting the position of the different offtakes from it of other rivers. Major Lang's report gave numerous sketches showing the distance between the offtakes of the Nadia rivers in different years, and plans which we have had prepared since exhibit similar characteristics which would always be liable to render absolutely useless elaborate training works designed to control the offtakes of any one season. Secondly, in dealing which such a volume of water there is the risk that it might get out of hand. The works erected to ensure a regular distribution might by some chance divert the main stream to an extent neither intended nor desired. We are constrained to admit the force of these objections.

35. If then it be agreed that no measures are practicable which would ensure a flow all the year round in the arteries immediately taking off from the Ganges, which would permit of its distribution in greater volume than at present through the streams which lead again from these, it may be said that it is unnecessary to consider the case of the latter, and this is so if it be a question of restoring the volume of these secondary streams throughout the year. That we believe to be an impossibility. But the matter is somewhat different in the rains. At that season a considerable volume of water does enter from the Ganges, and were communication between the arteries from the main river and their side streams intact, this water could be distributed through the latter sufficiently to give a temporary flush of greater current than flows at present. Whether this is worth doing is another matter; we are now concerned with its practicability. This idea of diverting one river down another is not a new one, but there are few instances on record of its successful accomplishment. Reference has already been made to the attempt about 1820 to make the water entering the Kumar proceed down the Mathabhanga (the converse of the end now in view). In 1823, Rs. 47,000 were spent in opening up the Bhairab in the hopes of improving the flow at Jessore and diminishing malaria. Major Lang reports as the result that "a stream was found to flow slowly past Jessore." It is very instructive to note that the works were destroyed by the flood of 1823, and that another Rs. 37,000 was sanctioned in 1824, with what result is not clear, but obviously it was unsuccessful. Mr. Westland mentions a futile endeavour to force the water of the Kabadak down the Lower Bhairab (apparently referring to the action taken in 1823-24), while as recently as the famine of 1896-97 a cut was made designed to bring water from the Mathabhanga at Shikarpur in Nadia into the Upper Bhairab; it is reported not to have been of sufficient depth and to have been therefore of little use. A scheme for re-opening the Nobogunga was put forward by the local officers in 1875, and was enquired into by Mr. Wickes, Executive Engineer. His estimate amounted to over Rs. 50,000 for earthwork alone (a recent estimate of the District Engineer of Nadia puts it at Rs. 1,11,672 for earthwork, turfing, and contingencies), and his conclusion, which was accepted by Government, was to the effect that "it is quite impracticable (to re-open the Nobogunga) at any reasonable cost; if opened, it would probably silt up again, and even supposing that it could successfully be kept open, the disadvantages would outweigh the advantages; for though it might supply water, when it is now needed, it would supply a great deal too much and would inundate the country disastrously (unless bunded) * * *" The evidence is not detailed, but Mr. Wickes surmised that an earlier effort had actually been made prior some time to 1850 to re-open the Nobogunga, which failed, as the cut again silted up. The same question which is now before us was in fact considered by the Nadia Fever Commission of 1882, and as the

fresh evidence which is available since that date is slight, we quote their opinion at some length as follows:—

> "In this tract we have a number of dead streams which were once large rivers; these are the Bhatahi, the Kabadak or Bhairab, the Noboganga and the Mysore Chitra, and the advantage which would accrue to numbers of villages in both Nadia and Jessore if these were re-opened has been pressed upon us in several quarters, and we fully admit this; we are, however, of opinion that the idea is impracticable. Mr. J. Fergusson in his paper on recent changes in the delta of the Ganges * * * has shown how the changes in these dead rivers occur, and why they leave their old beds and take new courses, and he aptly remarked that the course of nature in this matter can be no more interfered with than can a pendulum of 39 inches in length be made to beat once in two seconds of itself. It can be forced to do so for a time by the application of machinery, but directly the pressure is removed, it will rapidly return to its normal beat. So it is with these rivers; it is their office to raise the delta by the deposition of silt, and each river flows in a given course until it has completed its work when it either changes its direction or dies, and a new river is opened out elsewhere. The application of various expedients may retard the operation of natural laws for a time, but eventually nature will effect her end. The rivers above alluded to are already dead; to resuscitate them is practically impossible. The cause of the change above referred to is this. A river runs in a given course gradually elevating its bed and the country near it to or above the level of the rest of the adjacent delta, until one of two things happens: namely, either the river overflows into a lower tract of country, and commences to raise the new tract, or if that part of the delta is practically levelled up and completed, the river is gradually choked up by its own sediment and dies, and a new river is opened out in some other part of the delta, where the land is lower and requires raising. The above rivers have followed this latter course; the delta in Nadia and western Jessore has been raised and practically completed, and by the gradual deposition of silt the line of drainage which was formerly from north-west to south-east is now from north-east to south. In other words the work that had to be performed by the Bhairab, the Kabadak, the Noboganga and the Mysore Chitra has been completed and the rivers have died * * *.
>
> "Another point that has been urged is the Government has been apathetic in the past and that small amounts judiciously expended on the Noboganga, Bhairab and other rivers would have prevented their closing. We do not concur with this, for the reasons already given, but consider that any money spent would simply have been thrown away, and that the rivers were choked by natural laws which must have prevailed in the end. * * * *
>
> "On the general question of re-opening the whole of these rivers, we would remark that the Upper Matabhanga does not even now bring down sufficient water to prevent the Kumar from deteriorating. If such be the case, with a stream still living, how hopeless must it be to expect that the Matabhanga would, in addition, keep open a number of dead rivers like the Noboganga, Bhairab, etc., even should artificial connections be effected."

We do not know that there is much which we can usefully add. It is possible to re-open these silted-up heads, but without a detailed survey, we cannot give estimates of cost of any value. The recent estimate in the case of the Noboganga, referred to above, shows that the cost of such operations will be heavy, and there is no guarantee that it would be final. It might be necessary to repeat the operations yearly, and some fresh work annually would almost certainly be required. Moreover, there is always a danger that operations taken at one point in the channel of a river will have unexpected results elsewhere; for instance, it is conceivable that a diversion of a large body of water down the Bhairab would prejudicially affect the Ichamatti or the Choorni. In our opinion the evidence all points to the undesirability of such measures from an engineering standpoint.

The desirability from the point of view of the public health of opening up rivers silted at the head.

36. But it may be argued that in the interests of the public health the attempt should be made, and this remains to be considered. That a village situated on a live river is ordinarily more healthy than one lying upon the banks of a dead river, there can be little doubt, of which the figures reproduced in paragraph 27 are ample corroboration. But these rivers can never, as already explained, be reconverted into live streams by the action of man; they can only conceivably be flushed during the rains to a greater extent than at present, but it is not certain that even then there will be a very thorough flush. Of the benefits of such action, Captain Stewart and Lieutenant Proctor are sceptical. They hold it is of "doubtful benefit," and again that it "does not appear to offer any likely advantage." The argument is that in no case would it be likely to affect more than the strips of villages on either bank of the river (the instance of the villages of Satreejatpur, Benodepur, Rupdia and Dharamdaha, quoted in the Jessore report, shows that the healthy influence of a live river may extend only to its banks); that the dead river is only one

among other and possibly more dangerous sources of infection (the case of the villages of Shankarpur, Dharampur and Hariharpara, cited in the report dealing with the Murshidabad district, exhibits three villages all on the same stagnant river, in close proximity, but of very varying degrees of health); and that the flush will not probably be of sufficient volume to prevent the breeding of mosquitoes along the edges of the river during the rains (for instance, it is difficult to believe that the Bhairab at Jessore could ever be made much better than the khal at Satkhira, yet Satkhira was complained of as specially unhealthy). On the other hand, the drinking water supply will be slightly improved. On the whole, while we admit that the spleen rates of villages upon dead rivers are in most cases very high, and that some portion of this result must be attributed to the river, we are of opinion that any effect on health likely to be produced by a partial attempt to restore a current to the river during the rains will be slight, and not in proportion to the expense which it will be necessary to incur and the engineering risks which must be run. What money is available might be spent in other ways with better chances of success.

District.	Number of villages examined.	Average spleen rate.
Jessore	23	70·9
Nadia (Kumarkhali and Jibannagar thanas) ...	4	71
Nadia (Gangni thana) ...	4	66
Murshidabad ...	11	51·6

Influence of roads and embankments upon drainage.

37. While, in the foregoing remarks for the want of full information we have not specified in detail (with the partial exception of the silting up of rivers) the exact obstructions which exist to drainage in the Presidency Division, it is impossible to avoid reference to the alleged ill-effects of roads, railways and embankments, which loom largely in the provincial history of malaria, and which have again been asserted in the case of the Eastern Bengal State Railway in the course of our present enquiries. The charge against roads and railways in this respect gained weight from the advocacy of Raja Digambar Mitter at the time of the Epidemic Commission of 1864, but it is not always appreciated how often it has been enquired into since. During the years 1867 and 1868 an elaborate enquiry was held, the results of which were examined by Colonel Nicolls, Chief Engineer, in a note dated the 4th March 1869, in which he arrived at the conclusion that "roads and railways in Bengal have not obstructed the drainage of the country so far as to cause or to aggravate sickness. But some obstruction is inevitable and should be remedied as far as possible." The question crops up repeatedly in the reports of the officers who dealt with the Burdwan outbreak (1869—1875), but no one was able to discover that the epidemic had followed the lines of rail, and there was much evidence to the contrary. In 1877 a Committee was specially appointed to investigate certain localities in which it was alleged that the drainage had been so obstructed, a statement which their report did not accept, and the Lieutenant-Governor held that the conclusion still held good that "while Raja Digambar Mitter's theory was possibly right in some respects, artificial obstructions having in many cases occasioned, and in others aggravated, the outbreaks of fever, it had nevertheless been repeatedly demonstrated that the fever had prevailed in villages and in parts of the country on which roads and railways had had no possible effect." Between the years 1878 and 1881 the need of efficient drainage was actively urged by Government, it being admitted that if, as was possible, roads and railways had caused local obstructions, these should be ascertained and remedied. Enquiries were held, and Government noted in 1880 that, while much still remained to be done towards the improvement of local drainage, progress had been made. The subject was specially discussed by the Nadia Fever Commission of 1882, after a protracted local enquiry, and their conclusion was that "the outbreak of fever cannot be attributed to local obstruction to drainage from want of waterways in roads and railways." Finally, with reference to the riparian municipalities of the 24-Parganas, Captain Rogers noted in 1900 that "the places with the highest spleen rates lie for the most part to the east of the railway, while the reverse should be the case if the unhealthiness were mainly due to the obstructed drainage caused by the railway."

Resolution of the 31st July 1877.

Resolution of the 12th July 1880.

We have made reference to these earlier records, not for the purpose of arguing that obstructions to drainage in places by reason of roads and railways are no longer found, which is not the case (and in fact in the course of our enquiries we have supported a request for the insertion of a bridge in the Eastern Bengal State Railway over the Bhural khal near Porada), but for the purpose of combatting the impression, of which we found some evidence, that there is no need for local effort towards the improvement of the drainage conditions, and that all would be well if more culverts were only inserted in these highways of communication. Where such a definite local obstruction is alleged, by all means let it be enquired into and removed, if found to exist, but a general accusation against roads and railways helps little and really obscures the true issue. Malaria is not primarily due to such defects, nor will it be cured by their removal. We think it more probable that the construction of these embankments may have done injury to health, not so much by obstructing the course of drainage, but from the manner in which the earth heaped upon them has been excavated. Pits have been left which are undrained, and which become breeding grounds for mosquitoes of much the same character as the hollows surrounding the village sites. We think that more attention should be given to this point when these projects are under preparation, and that no plan should be accepted as complete which does not deal with the subsequent drainage of the borrow pits which are left alongside.

General conclusions.

38. In answer, therefore, to the second and third heads of the reference to us, we submit that the information available is insufficient to permit of a complete reply, and we recommend further enquiry both by engineering and medical officers in order to define more exactly the facts as regards the drainage of particular tracts of country, and, if possible, to trace the connection between particular defects of drainage and the prevalence of malarial fever. Pending such investigations, we can only say generally that conditions of obstructed drainage are favourable to the presence of malaria, and the nature and effect of these different obstructions we have endeavoured to explain. To those surrounding the villages themselves we ascribe the greatest importance, and it is in the light of the fact that they are common to almost all villages, coupled with a general neglect of sanitation, that we read the remark of Captain Stewart and Lieutenant Proctor that "it is difficult to believe that situation" (*i.e.* on dry land, bheels or rivers) "is the primary factor in the causation of malaria." Nevertheless the figures show that situations upon bheels and dead rivers are not conducive to good health. As regards the merits of drainage improvement as a remedy, it is difficult to see how the ill-effects of the extensive rice cultivation can be avoided, and we are not in favour of attempts to resuscitate rivers which have once died from natural causes. For the rest, much can be done so far as engineering is concerned, and we strongly recommend action. The difficulties are those of finance and agency. The former are common to all schemes; the latter are mainly felt in the execution of the numerous petty village works of improvement which must be largely left to local initiative and control.

CHAPTER V.

PRACTICABLE DRAINAGE SCHEMES IN THE PRESIDENCY DIVISION.

Schemes of drainage in the Presidency Division.

39. Having now defined the malarious areas in the Presidency Division and discussed the influence upon the prevalence of malaria of the existence of obstructions to drainage, we have been asked to furnish a list of practicable drainage schemes arranged in the order of their urgency. It follows from what has been already said that this is scarcely possible, and we propose, therefore, only to mention projects which have already been mooted, and regarding which information, more or less detailed, is available. We do not discuss the Magrahat scheme in the district of the 24-Parganas, although this is the most important project which has as yet been undertaken under the provisions of the Bengal Sanitary Drainage Act, since it is already in course of execution.

(*a*) *Murshidabad District—Berhampur and Gobra Nala schemes.*—In view of the extreme malariousness which characterises the central block of the Murshidabad district already described, we have no hesitation in giving precedence to the schemes which have been proposed for the improvement of its drainage. Taking the strip bounded on the west by the Bhagirathi (the project does not touch the Assanpur thana on the west of the river) and on the east by the Gobra nala, it is proposed (*i*) to remove obstructions from the course of the nala, thereby lowering the surface level of the water in it, and (*ii*) to drain into it the bheels known as Bistopur (2 square miles) and Chalta and Chandoo (8½ square miles) which at present lie to the east of the Berhampur station. Such is the scheme in its roughest outline. It has still to be elaborated, but we have seen the country round Berhampur, and assuming that further examination establishes the possibility of lowering the water in the bheels so as to leave a level dry surface and not a series of swampy holes, there is every prospect of its success. No estimate of cost has yet been framed, but the project as concerns the bheels is a continuation of one tried in 1872-73. Two drainage cuts were then made from the bheels to the nala, but experience has shown that they were of insufficient depth. The Gobra nala was originally probably an effluent of the Bhagirathi, and ran from that river to the Jalangi at Balee, about 50 miles; it is in fact the natural drainage channel of the country east of that river. Its head was closed by the Bhagirathi embankment, and it has now silted up at either end, although the water in the centre is deep and clear. It requires to be cleared and improved. In one sense the projects touching the bheels and nala respectively are separate, but they affect the same unhealthy tract and have therefore been mentioned together.

(*b*) *Jessore District—Bhairab Scheme.*—The second scheme of which we would advocate the importance is that dealing with the Bhairab in the neighbourhood of Jessore. After various vicissitudes it has at length reached the stage of the appointment of Commissioners under the Sanitary Drainage Act, who will deal with the improvement of the river above Jessore town and the drainage into it of the adjoining bheels, which are of the nature of marsh land. The scheme is in every way a desirable one. The unhealthiness of the area (practically the central drainage basin of the Jessore district) is undoubted, and if an improvement can be demonstrated by the measures proposed, it will afford a most valuable precedent for the similar treatment of country of the same description elsewhere.

(*c*) *24-Parganas—Bagjola Scheme.*—Third in order we would place the Bagjola project in the 24-Parganas, which will deal with an area of some 30 square miles, bounded on the west by the Hooghly, on the north by the Sodepur to Thakurpookar Road, on the east by the Calcutta-Jessore Road, and on the south by the zamindari embankments bordering upon the Salt Lakes, and will serve the municipalities of North and South Dum-Dum, Cossipore, Baranagore, Panihati and Kamarhatti, and the Dum-Dum Cantonment. At present the lower portions of this tract remain almost submerged during the rains, and during high tides the water from the salt marshes backs up and obstructs the drainage. The whole area is unhealthy. A scheme has been worked out at an estimated cost of four lakhs of rupees, or of two and a half lakhs in a less complete form.

(*d*) *24-Parganas—Nowai and Soonti Scheme.*—Reference has already been made to the unhealthiness of Baraset, and this may be taken as the centre of the tract which it has been suggested should be drained by opening up the Nowai and Soonti rivers lying on either side of it. Connected with this scheme is the re-excavation of the Ichapur khal, between Ichapur and Nilganj, which would drain the southern portion of the Naihatti thana. This would afford a good typical example of the improvement of rivers, the channels of which have been obstructed by tanks sunk in them, bandhs, fishing weirs and jungle. An application has been preferred by the District Board under the Sanitary Drainage Act. The suggestion is an old one and was made so far back as 1885. It collapsed owing to the difficulty of finance, the landholders declining to take action under the Embankment Act at an estimated cost of from 3½ to 4½ lakhs of rupees.

We would recommend immediately a concentration of energy on these four schemes. Even pending the creation of a special Engineering Division, there is no reason why they should be delayed. The Bhairab, Bagjola and Baraset schemes have already been investigated in some detail; the Berhampur project still requires to be worked up. All four touch typically malarious tracts, and present various features of different interest. The Berhampur and Bhairab schemes will demonstrate the advantages of draining bheels; the proposals regarding the Nawai and Soonti will affect streams whose actual channels are at present obstructed; and khals as distinct from rivers will be dealt with in the re-opening of the Gobra nala and the Bagjola and Ichapur khals. An object lesson will be afforded moreover in three different districts. The needs of Khulna are less urgent, and while we would have liked to have included Nadia in the programme, the knowledge of the local circumstances is not sufficiently exact to permit of this for the present. Past experience has shown that it is in the practical execution of such works that the difficulties occur; every one is in preliminary agreement as to the merits and are unanimous advocates of action; but it is one thing to launch a scheme and another to carry it through. If a special engineering staff can be made available for the elaboration of these projects, better results may be anticipated, but for the present good progress will have been made if in the near future these four proposals become accomplished facts, and this will more probably be achieved if attention is directed to them in particular, rather than ranging discursively over the whole area of the division. Pending more accurate estimates of the cost, it is impossible to recommend any definite assistance on the part of Government. We would only urge generally that such help should be liberal, and in fact in connection with the Magrahat scheme local effort has already been generously supported by Government. There is an element of experiment in these projects, and while the local residents should contribute in recognition of the benefits which will undoubtedly be conferred upon them, Government is also interested in the practical test of theories as to the connection between malaria and drainage. A few actual demonstrations of the results which can be achieved by drainage will do more to forward the general cause than an infinity of discussion and advice.

40. Since, however, other proposals have been laid before us in the course of our enquiries some of which are *primâ facie* desirable, although about all there is a great absence, so far, of detailed information, it will be convenient to enumerate them as a guide to subsequent enquiries. It is of course possible also in the meantime for the local officers to do something towards elaborating them, at any rate towards ascertaining the exact facts, and we would advise that they should be recommended to do so. As the schemes stand at present it is impossible to pronounce judgment upon them.

Jessore district.

(*i*) The re-excavation of the Muchikhali khal, with the idea of bringing water from the Gorai into the Kumar near Magura.

(*ii*) The drainage of the country along the course of the Beng.

(*iii*) The drainage of the country along the course of the Betna.

(*iv*) A connection between the Kumar and Nobogunga near Madiar Howar in the Jhenida subdivision, with the idea of bringing more water into the latter channel. A rough estimate of Rs. 10,000 has been mentioned as the likely cost. A suggestion to block the Dhopaghata khal has also been made in order to keep the water of the Nobogunga in its own bed, which at present is here diverted.

(*v*) The deepening of the Bhowanipur khal in the Jhenida subdivision with the same object, *i.e.*, in order to bring water from the Kumar to the Nobogunga. This is said to be likely to cost Rs. 20,000.

(*vi*) The re-opening of the Hanu river in the Magura subdivision by a connection with the Gorai. It is reported that the cut need only be about some 200 yards, and would cost Rs. 5,000. It is hoped thereby to improve the health of the Sripur outpost.

It will be observed that the old idea of diverting the water of one river into another figures largely in these suggestions. Although we express no final opinion, pending further examination of the facts, we would only note that past experience has shown that such schemes frequently fail in two ways: either the water will not continue to run in the artificial course designed, or the diversion of the water will do as much harm to the old channel as good to the new. The facts emphasise the importance of the maintenance of a special establishment for the examination of such proposals in the light of expert knowledge and accumulated experience.

Nadia district.

The information available with regard to the Nadia district is more than usually vague. The local officers urge generally that the silted-up entrance to the Jalangi should be re-excavated (*vide* paragraph 31); that the connection between the Upper Bhairab and the Jalangi should be restored at Karimpur, and that its channel should be generally opened up throughout its length of 85 miles to the Mathabhanga at Subalpur; that the Kaliganga and Dauki (branches from the Gorai in the Kushtia subdivision), the Kumar, the Ichamatti, the Gurguria (an old channel of the Bhagirathi in the Nakasipara thana), the Nobogunga, the Chitra and the Bhairab should be re-opened at their heads; that the Kajla khal (referred to by Captain Stewart and Lieutenant Proctor in the Gangni thana), the Margangni (an old connection between the Jalangi and Upper Bhairab in the Karimpur thana), the Sagarkhali (an old link between the Ganges and Mathabhanga in the Daulatpur thana), the old bed of the Gorai (traversing the Nayapara thana), and the khals known as Boalmaree (between the Jalangi and Bhairab in the Tehatta thana), Saraswatti (Tehatta and Meherpur thanas), Ranabandh (Damarhuda thana), Kalingha (Kissenganj thana), Bhaimara (Chuadanga thana) and Hangar (Ranaghat thana) should be re-excavated; and that the bheels named Charoikhal (in the Kumarkhali thana, referred to by Captain Stewart and Lieutenant Proctor), Chapaigachi, Augdea, Arua, Puddo, Bhandardaha, Champta, Bhalukha, Magrah and Bhomerah, dotted about the district, should be drained. This is obviously not a practicable programme. Much of it is impossible if what we have said above is accepted. It is merely a suggestion that the conditions of the district should be restored to what it is supposed they once were, but at one and the same time all these channels were almost certainly never current. As one decayed another was created. We cite this as an example of the impossibilities which are demanded in the name of drainage, and as a further argument for the need of responsible enquiry. The Commissioner (Mr. Collin) only supports the drainage of the Charoikhal bheel, for which a scheme is under preparation, and to this and possibly to the improvement of the Upper Bhairab attention may for the present be confined.

Murshidabad district.

(*i*) The improvement of the Boamaree channel in the Bhagwangola thana.

(*ii*) The drainage of an area round Choa in the Hariharpara thana. This is connected with the improvement of the Gobra nala. The scheme is estimated to cost Rs. 12,800, and comprises the clearance of silt in the Sooti channel from Trimohini to Ballee, as also between Partapur and Chandkati, with a cut from Chandkati to the Bhairab. Proceedings under the Drainage Act are under discussion.

(*iii*) A project affecting the country round Panchthupi in thana Barwan, dealing with the flood water of the Maurakhi river. Details have not yet been finally decided upon, but the estimated cost is Rs. 1,200, of which about Rs. 1,000, has been promised by public subscription.

These all seem *primâ facie* to be useful works and deserving of support. The public recognition of the advantages of drainage at Panchthupi is noticeable. It has also been suggested that the bheels named Goas (8 square miles), Domkole (6 square miles), and Telkar (7 square miles) might advantageously be drained. Captain Stewart and Lieutenant Proctor point out that the need in the case of the Telkar bheel is not urgent, and we would advise the local officers to direct their attention to the other proposals first.

Khulna district.

(*i*) *The improvement of the Satkhira khal.*—Although the figures of mortality only show an average annual death-rate from fever of 15 per mille (1901—1905) in the Satkhira town, the local accounts are emphatic as to its unhealthiness, which it is hoped to remedy by creating a greater flow in the adjacent khal. It has been suggested that this might be done either by throwing an embankment across the river Betna just below the junction of the khal with it on the north-east, thus diverting its waters into the khal, or by introducing the water of the Ichamatti by a series of cuts from Chanduria on the north-west. The whole scheme is very much in the air, and requires elaboration. We are not disposed to approve of the sacrifice of the present channel of the Betna south-east of Satkhira in the interests of that town, and as regards the alternative, all that seems known is that a previous enquiry feared the danger of inundation if the water of the Ichamatti was brought in. It is surmised that the risk no longer exists, but no levels have been taken, and we are not prepared to accept that opinion. The simple deepening of the khal stands as a project in the famine programme, but it is doubtful if this would have much effect upon health.

(*ii*) *The drainage of the Bagerhat Union.*—This is an unpretentious project which we would like to see carried out. The area to be dealt with is some 3½ square miles adjacent to Bagerhat. The statistics do not show it to be remarkably unhealthy, but it is no doubt susceptible of improvement. The cost, as roughly estimated, is Rs. 10,000, and Commissioners under the Sanitary Drainage Act were appointed in January 1906. So far nothing further has been done, owing apparently to local friction, and petitions of objection to the project were preferred before us. We think it a pity that the scheme should not be tried; its success would encourage similar action elsewhere.

A general idea exists locally that the Nalua river in thana Mollahat and the Betna river in thana Kalaroa should be improved, but nothing in the nature of a project is as yet forthcoming.

The 24-Parganas.

(*i*) We reprint as Appendix II a report by the Executive Engineer regarding the drainage needs of the country in the vicinity of Diamond Harbour, since this affords a good example of the information which we recommend should be collected gradually as regards the whole division, as the only sure basis of any action upon a large scale. The needs of the particular area dealt with are mostly in the nature of sluices in protective embankments with connecting drains, and are so far to some extent special, although this does not affect the general principle.

(*ii*) *The improvement of the Baghar khal.*—This khal runs into the Hooghly on the west near Kanchrapara; further east it is known as the Jamuna, and it ultimately connects with the Ichamatti at Goala ghât. Its total length is about 30 miles, and in a portion of its course it forms the boundary between the districts of Nadia and the 24-Parganas. The khal was once navigable, but its connection with the Hooghly having silted up, it is now no longer so. The question of its re-excavation is not a new one. It was enquired into in 1875, and then dropped, partly on the ground of expense, but doubts were also expressed as to whether it was a practicable work, a view which was endorsed by the Nadia Fever Commission. It was again raised in 1895, but the suggestion that it should be taken up under the Sanitary Drainage Act came to nothing. Finally, it came up again in 1902, and a project was prepared in the succeeding year at an estimated cost of about 4 lakhs of rupees. It is now before the District Board, which, we understand, is about to recommend action under the Sanitary Drainage Act.

(*iii*) *Schemes connected with the re-excavation of various khals.*—The more important schemes are the following:—

(*a*) The Mukhtapur khal.
(*b*) The Titaghar khal.
(*c*) The Khardaha khal. (This was excavated in 1904 at a cost of about Rs. 11,000, but is reported to have again silted up.)
(*d*) The Manikhali and Jinjir khals.
(*e*) The Moraganga khal.

There are also municipal schemes which affect these and other khals, but no final plans are as yet available.

CHAPTER VI.

SUMMARY OF CONCLUSIONS.

Summary.

41. The conclusions at which we have arrived as the result of our enquiries may now be summarised as follows:—

(1) While malaria is prevalent over the Presidency Division as a whole, it may be said to be especially severe over an area of some 5,780 square miles, situated for the most part in the districts of Jessore and Nadia.

(2) While the districts of Jessore and Nadia, as a whole, are the most malarious in the division, there is a tract of some 919 square miles in the district of Murshidabad in which the disease is of marked virulence.

(3) We are unable to carry the unit of comparison in the division as a whole below the thana, but the most unhealthy thanas have been classified in paragraph 16.

(4) We advocate the need of systematic local medical investigation in order to determine the exact prevalence of malaria within individual thanas, the extent to which deaths reported from "fever" are in reality due to malaria, and the conditions governing the distribution of the disease which may afford a basis for remedial action. Until the available information upon these and kindred points is more exact than is at present the case, such enquiries should be a regular feature of each fever season. Such investigations must necessarily be entrusted for the most part to special officers, but the co-operation of Civil Surgeons and the officers of the Sanitary Department should be encouraged.

(5) The obstruction of drainage, in so far as it increases the facilities for the breeding of mosquitoes and induces a waterlogged condition of the soil which is prejudicial to health generally, may be said to be a cause of malaria.

(6) It is not possible at present to specify in detail the obstructions to drainage which exist in the areas defined as specially malarious. Such obstructions are characteristic of the division generally, and may exist either in the village sites, in the surrounding rice fields, in the bheels, or in the khals and river channels into which the latter drain.

(7) We propose the creation, at the public expense, of a special Engineering Division, charged with the examination of the drainage conditions of specified areas, and the preparation of projects for their improvement, where necessary.

(8) Systematic action should be taken to record information regarding the annual changes in the course and volume of rivers, as also observations touching the height of the subsoil water at different periods of the year.

(9) While the efficient drainage of village sites is practicable, as a matter of engineering, the vast number of villages to be dealt with, the absence of a strong local organisation, the difficulty of funds, and the apathy of popular opinion render it unlikely that it can be effected in the immediate future. Effort should be concentrated upon the execution of such projects in municipal areas, which are frequently merely large villages, and the demonstration in selected localities at Government expense of the improvement in the public health which may be anticipated if the drainage is improved.

(10) It is not practicable in the immediate future to restrict the cultivation of rice in the vicinity of villages, although the absence of such a prohibition entails the continuance of conditions favourable to malaria.

(11) Assuming the definition of the bheel areas which may be described as water-logged, energetic action should be taken to encourage the execution of schemes calculated to improve their drainage, towards which Government should contribute.

(12) Similar action should be taken in the case of the khals and river channels which have been obstructed in their course by the deposit of silt, or by artificial obstacles of any description.

(13) Action designed to re-open at their heads rivers which from natural courses have closed, and which no longer convey through their channels the water of larger streams of which they were once the distributaries, is not expedient.

(14) As definite schemes of drainage which are practicable and may desirably be executed in the near future, we suggest the following in the order of their urgency:—

(*a*) The Berhampur-Gobra Nala project.
(*b*) The Bhairab scheme.
(*c*) The Bagjola scheme.
(*d*) The Nowai-Soonti project.

(15) In paragraph 40 we have made mention of other projects which are not yet sufficiently advanced to permit of a final decision as to their merits; with some of these progress can be made in the meantime; others will form a suitable subject for enquiry by the special engineering establishment proposed.

(16) As incidental recommendations we propose (*a*) the experimental compilation, in selected thanas, of vital statistics for individual chaukidari unions; (*b*) the experimental despatch of itinerant Civil Hospital Assistants to distribute medical assistance in malarious localities during the fever season; and (*c*) proper provision for the drainage of the borrow pits left by the side of railways, embankments, etc.

Conclusion.

42. In conclusion we desire to record our acknowledgments of the energy and ability displayed by Captain Stewart and Lieutenant Proctor upon whom the task of detailed local research devolved under circumstances of considerable personal discomfort. Our best thanks are due for the reports submitted by these officers.

W. A. INGLIS, P.W.D.,
Member and President.

F. C. CLARKSON, LT.-COL., I.M.S.,
Member.

H. WHEELER, I.C.S.,
Member and Secretary.

STATEMENT I

Showing the total annual death-rate per mille from all causes during ten years in the districts of the Presidency Division.

DISTRICT.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1804.	1905.	Annual average for 10 years 1896—1905.	Annual average for 5 years 1901—1905.
1	2	3	4	5	6	7	8	9	10	11	12	13
Jessore	37·4	33·3	30·5	41·6	37·3	34·7	42·5	37·4	42·4	39·3	37·6	39·2
Nadia	36·1	26·1	22·0	36·9	38·8	33·0	50·0	40·7	39·8	46·6	37·0	42·0
Murshidabad	32·7	28·4	24·6	43·0	39·7	33·5	37·9	36·3	38·8	42·1	35·7	37·7
Khulna	35·8	34·2	29·0	35·1	38·8	28·2	32·9	33·4	33·0	34·3	33·4	32·3
24-Parganas	29·5	24·4	22·2	27·3	29·6	23·1	30·6	31·1	28·1	29·0	27·4	28·3

STATEMENT II

Showing the annual death-rate per mille from "fever" during ten years in the districts of the Presidency Division.

DISTRICT.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	Annual average for ten years 1896—1905.	Annual average for five years 1901—1905.
1	2	3	4	5	6	7	8	9	10	11	12	13
Jessore	30·7	27·1	26·7	35·2	30·8	28·2	36·0	31·3	33·9	33·0	31·2	32·4
Nadia	25·4	19·1	17·0	30·2	30·1	26·9	40·8	32·0	29·6	37·3	28·8	33·3
Murshidabad ...	24·3	21·9	19·8	34·0	31·7	27·0	30·8	29·4	29·5	32·2	28·0	29·7
Khulna	23·7	22·9	21·1	24·3	24·6	18·4	21·1	21·4	21·1	22·0	22·0	20·8
24-Parganas ...	20·0	18·4	17·6	20·5	20·5	15·7	18·7	19·1	18·7	19·3	18·8	18·3

STATEMENT III

Showing the thanas of the Jessore district arranged according to the order of their average annual mortality per mille in rural areas (a) *from all causes,* (b) *from fever during the five years 1901—1905; and showing the variations of population in each between the censuses of 1881, 1891 and 1901; and the proportion of births to deaths during the quinquennium 1901—1905.*

Serial No.	NAME OF THANA.	Annual average mortality from all causes.	Serial No.	NAME OF THANA.	Annual average mortality from fever.
1	2	3	4	5	6
1	Barkalia	33·71	1	Barkalia	27·70
2	Gadkhali	35·00	2	Kotchandpur ...	28·79
3	Keshabpur	35·10	3	Lohagara	29·24
4	Manirampur ...	35·41	4	Gadkhali	29·79
5	Jessore	35·77	5	Sarsha	30·53
6	Lohagara	36·53	6	Jessore	30·69
7	Sarsha	36·71	7	Manirampur ...	31·06
8	Salkopa	39·57	8	Keshabpur	31·29
9	Kaliganj	39·79	9	Moheshpur	32·94
10	Moheshpur	40·28	10	Bongaon	33·20
11	Bongaon	40·64	11	Narail	33·22
12	Kotchandpur ...	41·35	12	Salkopa	33·46
13	Narail	41·52	13	Kaliganj	33·98
14	Jhenida	42·29	14	Muhammadpur ...	34·82
15	Muhammadpur ...	42·35	15	Magura	34·93
16	Magura	43·15	16	Bagharpara	35·03
17	Bagharpara	43·89	17	Gaighata	35·95
18	Gaighata	46·45	18	Salikha	37·12
19	Salikha	47·97	19	Jhenida	37·31

NAME OF THANA.	PERCENTAGE OF VARIATION OF POPULATION BETWEEN CENSUSES		Total births, 1901—1905.	Total deaths, 1901—1905.	Net excess or deficit of births in comparison with deaths.
	1891—1901.	1881—1891.			
7	8	9	10	11	12
Barkalia ...	+4·9	+11·7	15,897	14,413	+ 1,484
Kotchandpur ...	—2·5	— 6·1	5,449	6,456	— 1,007
Lohagara ...	—2·5	+11·2	21,258	20,571	+ 687
Gadkhali ...	—4 6	— 5·5	10,484	10,632	— 148
Sarsha ...	—2·9	—11·1	12,407	12,517	— 110
Jessore ...	—7·5	— 5·6	21,123	24,689	— 3,566
Manirampur ...	—4·9	— 3·8	21,452	25,191	— 3,739
Keshabpur ...	—7·5	— 3·0	12,689	13,441	— 752
Moheshpur ...	—3·6	— 8·2	16,035	19,156	— 3,121
Bongaon ...	—4·6	— 7·4	18,329	21,669	— 3,340
Narail ...	+1·7	+ 0·1	26,470	32,012	— 5,542
Salkopa ...	—0·4	+ 0·4	29,776	35,602	— 5,826
Kaliganj ...	—2·1	— 6·9	11,888	16,172	— 4,284
Muhammadpur ...	—8·5	+ 8·3	14,999	17,584	— 2,585
Magura ...	—9·7	+ 4·3	23,106	32,342	— 9,236
Bagharpara ...	—5·9	— 9·8	9,275	11,909	— 2,634
Gaighata ...	—4·4	— 9·7	7,994	10,047	— 2,053
Salikha ...	—4·3	— 8·0	7,321	10,665	— 3,344
Jhenida ...	—5·8	—12·3	13,075	17,907	— 4,832
Whole district ...	—4·0	— 2·6	299,027	352,975	—53,948

STATEMENT IV

Showing the thanas of the Nadia district arranged according to the order of their average annual mortality per mille in rural areas (a) *from all causes,* (b) *from fever during the five years 1901—1905; and showing the variations of population in each between the censuses of 1881, 1891 and 1901; and the proportion of births to deaths during the quinquennium 1901—1905.*

Serial No.	NAME OF THANA.	Annual average mortality from all causes.	Serial No.	NAME OF THANA.	Annual average mortality from fever.
1	2	3	4	5	6
1	Chapra	35·84	1	Krishnagar	27·36
2	Krishnagar	37·22	2	Chapra	28·83
3	Chakdaha	39·39	3	Chakdaha	28·53
4	Alamdanga	39·78	4	Meherpur	29·65
5	Kushtia	39·90	5	Santipur	30·14
6	Damurhuda	40·51	6	Damurhuda	31·03
7	Meherpur	40·80	7	Ranaghat	31·40
8	Kissenganj	40·99	8	Alamdanga	31·45
9	Kaliganj	41·65	9	Kissenganj ...	31·51
10	Santipur	41·89	10	Nakasipara	32·74
11	Daulatpur	42·46	11	Kaliganj	32·84
12	Ranaghat	42·91	12	Hanskhali	33·30
13	Nakasipara	42·95	13	Daulatpur	33·31
14	Tehatta	43·71	14	Kushtia	33·37
15	Chuadanga	43·95	15	Tehatta	34·08
16	Hanskhali	44·14	16	Chuadanga	34·86
17	Nayapara	45·05	17	Nayapara	36·36
18	Karimpur	45·61	18	Kumarkhali	38·65
19	Kumarkhali	45·62	19	Jibannagar	39·15
20	Gangni	46·03	20	Karimpur	40·22
21	Jibannagar	48·29	21	Gangni	40·96

NAME OF THANA.	PERCENTAGE OF VARIATION BETWEEN CENSUSES OF—		Total births, 1901—1905.	Total deaths, 1901—1905.	Net excess or deficit of births in comparison with deaths.
	1891—1901.	1881—1891.			
7	8	9	10	11	12
Krishnagar ...	− 5·7	− 6·1	15,164	13,330	+ 1,834
Chapra ...	+ 3·1	...	13,887	11,735	+ 2,152
Chakdaha ...	− 7·4	− 4·0	15,968	16,917	− 949
Meherpur ...	+ 6·3	− 3·0	15,370	13,893	+ 1,477
Santipur ...	− 8·2	+ 0·1	4,259	4,747	− 488
Damurhuda ...	+ 9·6	+ 0·5	13,728	14,079	− 351
Ranaghat ...	− 1·5	− 8·4	11,857	13,791	− 1,934
Alamdanga ...	+ 1·7	− 0·2	18,382	18,150	+ 232
Kissenganj ...	+15·4	− 0·1	6,931	7,724	− 793
Nakasipara ...	+ 0·6	− 5·6	10,514	12,181	− 1,667
Kaliganj ...	+12·7	−13·4	11,094	10,995	+ 99
Hanskhali ...	+14·5	−17·6	8,085	9,441	− 1,356
Daulatpur ...	− 0·1	+ 4·2	19,221	17,845	+ 1,376
Kushtia ...	+ 7·2	+10·7	20,254	21,580	− 1,326
Tehatta ...	+ 7·7	− 2·2	19,957	20,512	− 555
Chuadanga ...	+ 1·6	− 8·1	10,757	12,560	− 1,803
Nayapara ...	+ 2·2	+ 2·5	28,426	32,429	− 4,003
Kumarkhali ...	− 4·7	+ 8·4	27,013	32,009	− 4,996
Jibannagar ...	+ 1·5	− 9·9	6,456	8,864	− 2,408
Karimpur ...	− 5·5	+ 3·9	20,921	23,022	− 2,101
Gangni ...	+ 8·5	− 2·3	16,681	18,292	− 1,611
Whole district ...	+ 1·4	− 1·1	314,925	334,096	−19,171

STATEMENT V

Showing the thanas of the Murshidabad district arranged according to the order of their average annual mortality per mille in rural areas (a) *from all causes,* (b) *from fever during the five years 1901—1905; and showing the variations of population in each between the censuses of 1881, 1891 and 1901; and the proportion of births to deaths during the quinquennium 1901—1905.*

Serial No.	NAME OF THANA.	Annual average mortality from all causes.	Serial No.	NAME OF THANA.	Annual average mortality from fever.
1	2	3	4	5	6
1	Khargaon	30·01	1	Khargaon	18·85
2	Shamshirganj	31·04	2	Kandi	20·33
3	Kandi	31·51	3	Barwan	21·68
4	Gokaran	32·04	4	Gokaran	23·22
5	Raghunathganj	32·34	5	Raghunathganj	23·86
6	Barwan	32·48	6	Bharatpur	24·52
7	Suti	32·49	7	Mirzapur	24·60
8	Mirzapur	32·98	8	Shamshirganj	25·58
9	Bharatpur	34·02	9	Suti	26·50
10	Nobogram	34·61	10	Sagardighi	26·89
11	Diwansarai	35·09	11	Barwa	28·90
12	Sagardighi	35·36	12	Diwansarai	29·50
13	Barwa	36·55	13	Nobogram	30·01
14	Gowas or Raninagar	39·96	14	Noada	32·09
15	Jalangi	43·88	15	Gowas or Raninagar	35·09
16	Bhagwangola	45·66	16	Jalangi	36·70
17	Noada	45·95	17	Hariharpara	37·74
18	Hariharpara	47·64	18	Bhagwangola	40·29
19	Gorabazar	49·06	19	Gorabazar	42·22
20	Daulatbazar	50·23	20	Daulatbazar	43·48
21	Sujaganj	51·98	21	Sujaganj	47·26
22	Manullabazar	53·19	22	Assanpur	48·40
23	Assanpur	53·91	23	Shahanagar	48·61
24	Shahanagar	57·59	24	Manullabazar	49·29

NAME OF THANA.	PERCENTAGE OF VARIATION OF POPULATION BETWEEN CENSUSES OF		Total births, 1901—1905.	Total deaths, 1901—1905.	Net excess or deficit of births in comparsion with deaths.
	1891—1901.	1881—1891.			
7	8	9	10	11	12
Khargaon	+ 12·9	+ 3·6	13,315	9,572	+ 3,743
Kandi	+ 12·5	— 1·7	4,084	3,134	+ 950
Barwan	+ 9·8	+ 3·5	14,519	11,339	+ 3,180
Gokaran	+ 16·7	— 5·8	9,636	7,467	+ 2,169
Raghunathganj	+ 10·7	— 9·8	14,508	10,122	+ 4,386
Bharatpur	+ 11·6	+ 1·0	25,785	20,744	+ 5,041
Mirzapur	+ 9·3	+ 2·8	9,775	7,548	+ 2,227
Shamshirganj	+ 11·9	+ 14·0	21,887	13,791	+ 8,096
Suti	— 6·4	+ 4·5	15,219	10,471	+ 4,748
Sagardighi	+ 26·0	+ 5·5	8,118	6,557	+ 1,561
Barwa	+ 8·3	+ 1·1	14,143	13,601	+ 542
Diwansarai	+ 1·5	+ 10·3	14,205	10,814	+ 3,391
Nobogram	+ 26·3	+ 1·3	10,227	8,230	+ 1,997
Noada	+ 6·2	+ 2·5	11,037	11,906	— 869
Gowas	+ 3·9	+ 9·0	19,038	17,775	+ 1,263
Jalangi	+ 3·2	+ 4·0	22,546	25,555	— 3,009
Hariharpara	+ 8·9	— 3·6	10,397	13,623	— 3,226
Bhagwangola	+ 4·7	— 6·3	13,051	12,808	+ 243
Gorabazar	+ 0·02	— 4·8	2,309	2,949	— 640
Daulatbazar	— 4·2	— 1·4	7,322	9,380	— 2,058
Sujaganj	— 0·3	+ 12·7	1,811	2,437	— 626
Assanpur	+ 0·6	— 9·3	1,949	2,770	— 821
Shahanagar	— 18·9	+ 17·4	2,040	2,918	— 873
Manullabazar	— 18·6	+110·4	542	875	— 333
Whole district	+ 6·6	+ 1·9	267,463	236,386	+31,077

STATEMENT VI

Showing the thanas of the Khulna district arranged according to the order of their average annual mortality per mille in rural areas (a) *from all causes,* (b) *from fever during the five years 1901—1905*; *and showing the variations of population in each between the censuses of 1881, 1891 and 1901; and the proportion of births to deaths during the quinquennium 1901—1905.*

Serial No.	NAME OF THANA.	Annual average mortality from all causes.	Serial No.	NAME OF THANA.	Annual average mortality from fever.
1	2	3	4	5	6
1	Paikgachha ...	22·60	1	Kaliganj	14·28
2	Kaliganj	24·61	2	Paikgachha ...	14·55
3	Satkhira	30·19	3	Assasuni	18·83
4	Rampal	33·30	4	Rampal	19·83
5	Magura	34·23	5	Bagerhat	21·33
6	Morelganj	34·73	6	Morelganj ...	21·35
7	Bagerhat	35·32	7	Satkhira	22·10
8	Khulna	35·75	8	Khulna	22·55
9	Damuria	36·11	9	Baitaghata ...	23·24
10	Assasuni	36·42	10	Damuria ...	24·95
11	Kalaroa	36·62	11	Magura	25·70
12	Baitaghata ...	38·30	12	Mollahat	26·46
13	Mollahat	39·17	13	Kalaroa	26·87

NAME OF THANA.	PERCENTAGE OF VARIATION OF POPULATION BETWEEN CENSUSES OF		Total births, 1901—1905.	Total deaths, 1901—1905.	Net excess or deficit of births in comparison with deaths.
	1891—1901.	1881—1891.			
7	8	9	10	11	12
Kaliganj ...	+ 6·1	+ 2·3	34,820	20,016	+14,804
Paikgachha ...	+49·7	+18·2	25,979	14,111	+11,868
Assasuni ...	—11·9	+14·6	19,511	10,059	+ 9,452
Rampal ...	+10·7	+11·8	13,454	10,266	+ 3,188
Bagerhat ...	+ 2·6	+10·1	30,857	27,517	+ 3,340
Morelganj ...	+12·4	+18·1	16,916	14,440	+ 2,476
Satkhira ...	— 1·7	+ 7·2	19,573	13,924	+ 5,649
Khulna ...	+ 8·4	+11·5	27,369	25,670	+ 1,699
Baitaghata ...	+ 9·8	— 1·2	8,851	7,787	+ 1,064
Damuria ...	+ 4·1	+ 5·3	16,269	14,854	+ 1,415
Magura ...	+ 0·3	+10·7	17,344	15,633	+ 1,711
Mollahat ...	+ 5·6	+17·1	12,936	12,234	+ 702
Kalaroa ...	—10·1	— ·2	14,975	13,140	+ 1,835
Whole district ...	+ 6·4	+ 9·0	258,854	199,651	+59,203

STATEMENT VII

Showing the thanas of the 24-Parganas district arranged according to the order of their average annual mortality per mille in rural areas (a) *from all causes,* (b) *from fever during the five years 1901—1905; and showing the variations of population in each between the censuses of 1881, 1891 and 1901; and the proportion of births to deaths during the quinquennium 1901—1905.*

Serial No.	NAME OF THANA.	Annual average mortality from all causes.	Serial No.	NAME OF THANA.	Annual average mortality from fever.
1	2	3	4	5	6
1	Bhangar	22·95	1	Budge-Budge	14·28
2	Haroa	24·23	2	Diamond Harbour ...	14·43
3	Canning	24·72	3	Matla or Canning ...	14·48
4	Basirhat	25·58	4	Bhangar	14·82
5	Tollyganj	26·61	5	Hasanabad	15·09
6	Budge-Budge	26·78	6	Jaynagar	15·15
7	Jaynagar	26·80	7	Haroa	15·97
8	Hasanabad	26·88	8	Vishnupur	17·24
9	Sonarpur	27·04	9	Kalpi	17·43
10	Vishnupur	28·39	10	Basirhat	18·97
11	Baduria	28·52	11	Baruipur	19·02
12	Kalpi	29·33	12	Falta or Debipur ...	19·42
13	Baruipur	29·89	13	Mathurapur	19·52
14	Diamond Harbour ...	30·02	14	Sonarpur	19·73
15	Falta	30·11	15	Magrahat	20·19
16	Baraset	31·40	16	Tollyganj	20·22
17	Diganga	32·35	17	Baraset	21·85
18	Mathurapur	32·84	18	Baduria	22·45
19	Magrahat	33·52	19	Habra	25·71
20	Habra	34·71	20	Diganga	27·09
21	Nawabganj	40·72	21	Nawabganj	29·88
22	Naihati	41·84	22	Naihati	31·41
23	Barrackpore	42·16	23	Barrackpore	32·33
24	Khardaha	52·11	24	Khardaha	39·96
25	Dum-Dum*	64·91	25	Dum-Dum*	47·51

NAME OF THANA.	PERCENTAGE OF VARIATION OF POPULATION BETWEEN CENSUSES OF		Total births, 1901—1905.	Total deaths, 1901—1905.	Net excess or deficit of births in comparison to deaths.
	1891—1901.	1881—1891.			
7	8	9	10	11	12
Budge-Budge ...	+ 13·9	+ 15·5	12,132	9,282	+ 2,850
Diamond Harbour ...	+ 11·4	+ 20·0	12,898	10,610	+ 2,288
Matla or Canning ...	+ 41·9	+ 18·9	12,011	9,915	+ 2,096
Bhangar	+ 12·6	+ 4·4	13,091	8,780	+ 4,311
Hasanabad	+ 15·3	+ 18·0	18,544	11,610	+ 6,934
Jaynagar	+ 18·6	+ 19·5	13,009	13,292	— 283
Haroa	— 2·0	+ 27·4	10,692	7,461	+ 3,231
Vishnupur	+ 6·2	+ 10·2	16,179	11,924	+ 4,255
Kalpi	+ 26·8	+ 18·0	19,881	19,819	+ 62
Basirhat	+ 10·7	+ 2·8	13,559	8,954	+ 4,605
Baruipur	+ 4·6	+ 14·3	14,003	12,938	+ 1,065
Falta or Debipur ...	+ 5·2	+ 14·6	19,927	7,891	+ 2,036
Mathurapur	+ 23·0	+ 16·1	12,672	12,206	+ 466
Sonarpur	+ 3·3	— 0·4	5,890	4,453	+ 1,437
Magrahat	+ 4·8	+ 16·0	20,078	21,865	— 1,787
Tollyganj	+ 1·4	+ 29·1	10,287	8,866	+ 1,421
Baraset	+ 1·3	+ 3·4	17,894	14,310	+ 3,584
Baduria	+ 4·6	+ 2·1	21,385	17,017	+ 4,368
Habra	— 0·9	- 5·4	11,424	11,244	+ 180
Diganga	— 1·0	+ 4·2	11,414	8,931	+ 2,483
Nawabganj	— 7·9	+ 69·2	237	248	— 11
Naihati	+ 11·8	+ 11·8	6,952	7,516	— 564
Barrackpore	+ 28·1	— 9·2	722	935	— 213
Khardaha	+ 7·5	+ 15·9	1,021	1,682	— 661
Dum Dum	+ 1·4	+ 18·8	4,131	4,021	+ 110
Whole district ...	+ 9·9	+ 11·8	290,033	245,760	+44,273

* Not a true rate. In 1904 the area of the thana was altered and this fact was not properly allowed for in the calculation.

APPENDICES.

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APPENDIX I (*vide* paragraph 3).

No. 38, dated Calcutta, the 15th March 1907.

From—CAPTAIN G. E. STEWART, I.M.S., on special duty with the Drainage Committee, Bengal,

To—The Secretary to the Drainage Committee, Bengal.

WITH reference to the orders of Government placing Lieutenant Proctor, I.M.S., and myself on special duty in connection with the enquiries of the Drainage Committee in the districts of the Presidency Division, I have the honour to submit herewith our final report. *Interim* reports dealing separately with the districts of Jessore, Nadia and Murshidabad have already been communicated to the Committee. These may be read as supplementary to the final conclusions now offered.

Final report on the districts of Jessore, Nadia and Murshidabad.

THIS enquiry was undertaken in connection with the Drainage Committee, Bengal, to ascertain the prevalence of malaria, the actual mortality due to malaria, and the connection, if any, between the want of natural drainage and malaria in the districts of the Presidency Division. For this purpose, Captain G. E. Stewart, I.M.S., was placed on special duty from 7th August 1906, and Lieutenant A. H. Proctor, from 1st August 1906. Both officers proceeded to the Central Research Institute, Kasauli, and remained there till 8th October 1906 engaged in a preliminary course of work in the laboratory. In the Jessore district, work was commenced on 18th October 1906 and was completed on 23rd December 1906; the Nadia district was visited between 4th January 1907 and 19th January 1907; and the Murshidabad district between 25th January 1907 and 23rd February 1907. Captain Stewart and Lieutenant Proctor reverted from special duty on the 15th March 1907.

2. The area visited in the Jessore district included the Sadar, Jhenida, Magura and Narail subdivisions; in Nadia the Kumarkhali, Jibannagar and Gangni thanas; and in Murshidabad the Sujaganj, Shahanagar, Manoolla Bazar, Bhagwangola, Lallgola and Hariharpara thanas, and a strip of land on the west side of the Bhagirathi river, opposite Berhampore and Murshidabad..

3. *Character of the country.*—The country is a flat alluvial plain intersected by several rivers taking their origin from the Ganges, and by numerous lesser channels and khals, some of which also were formerly branches from the Ganges or from the larger rivers, but have now lost their connections with the "feeder" streams, and have become merely channels for local drainage. The main rivers in the country visited, such as the Bhagirathi, Jalangi, Matabhanga, Kumar, Gorai, Madhumati, the Noboganga below Magura, and the Chitra in the Narail subdivision, though they have degenerated considerably, still have clear, flowing streams, high banks, and a sandy bottom free from weeds. These are referred to in the following report as "live" rivers. The channels which have lost their "feeder" connections, and have become merely local drainage channels, are referred to as "dead" rivers. For the greater part of the year, there is practically no current in them, and they become long weed-grown bheels. Some dry up still more, leaving only a chain of stagnant pools. The most important of these in the areas visited are the Bhairab, Chitra and the upper portion of the Noboganga in the Jessore district; the Bhairab, Cobadak and Kajla Khal in Nadia; and the Gobra Nala and Bhairab in Murshidabad. The rivers in the Jessore district in their lower reaches are affected by the tide.

After the rainy season a great portion of the country is practically under water, either from the overflowing of neighbouring rivers or from the local rainfall; many of the villages are flooded and some even have to be evacuated. On ther drying up of the land extensive bheel areas are left, some of which remain stagnant thoughout the year. Some of these bheels are connected with the rivers by khals, through which they receive water from the rivers at the time of high floods and drain into the rivers when these fall, but in many cases the bheels have lost their connections with the rivers either owing to the silting up of the khals or alterations in the course of the rivers.

Rice is the great staple product of the country, and its cultivation is carried on extensively often in close proximity to the villages. For this purpose it is necessary to keep the water on the land until about the middle of November, after which it is allowed to drain off. Jute-growing forms a large and increasing industry in many parts of the country, and jute-steeping is carried on in ponds and tanks in or near the villages and in the neighbouring rivers.

4. *Village conditions.*—The villages generally consist of a number of separate homesteads scattered over a considerable area. The houses are built of spilt bamboo and are usually raised on a mud plinth. Cattle-sheds are built in close proximity to the houses, and the whole generally encloses a central courtyard towards which the houses face. The mud for the plinth, etc., is taken from pits dug in the immediate neighbourhood of the houses. After the rainy season these pits remain full of water for a long period. No cultivation is carried on, as a rule, in the villages, but jungle is allowed to grow at will and is often extremely dense, so that sun and air cannot get at the houses, the soil remains damp for a long time after the rains, and the pits and casual collections of water in the villages evaporate very slowly.

The drinking water-supply is usually very bad. Pucka wells are almost unknown except in the municipalities; kutcha ring-wells are common, but are often not used for drinking purposes owing to religious scruples. Tanks are very common in the villages, and form the usual water supply when there is no river handy; they are generally very dirty and weed-grown and are used for washing and other domestic purposes as well as for drinking. Where no tanks or wells exist, drinking water is got from any casual collection of water, and is often stinking and filthy. When river water is drunk it is generally obtained at a spot which is also used as a bathing ghat. The sides of the rivers and nalas, and the jungle surrounding the houses are the usual places used as latrines.

5. *Sub-soil water levels.*—Observations were made on the water level in wells where these existed, and information was obtained, where possible, from the owners as to the height to which the water rose at the end of the rains, with a view to estimating the level of the subsoil water. The figures are given in the *interim* reports already submitted. The water levels at the time of visit and also the amount of fall which had taken place since the rains can of course only be used to compare places which were examined nearly at the same time.

In the Jessore district there were few wells in the villages, especially in the Magura and Narail subdivisions. The average depth of the water from the ground at the end of the rains in 27 villages was 4·1 feet. In the Nadia district the average depth in 34 villages was 3·1 feet. The average depth was greater in the Gangni thana, where the spleen-rates found were higher, and was less in the Kumarkhali and Jibannagar thanas, where the spleen-rates were smaller, but this was probably due to the large amount of Leishman-Donovan infection in Gangni, which, as far as is known, has no connection with the subsoil water-level. In the Murshidabad district the average depth after the rains in 43 villages was 2·7 feet. In the Sujaganj, Shahanagar, Manoolla Bazar and Hariharpara thanas, where the spleen-rates found were higher, the average subsoil water-level after the rains in 22 villages was 3·6 feet; and in the Bhagwangola and Lallgola thanas, where the spleen-rates were lower, the average subsoil water-level in 20 villages was only 1·4 feet. The high spleen-rates do not therefore correspond with the tracts of country having the highest subsoil water after the rains.

6. *Prevalence of fever.*—This was estimated by taking spleen-rates in children under 12 years of age. In the three districts visited 13,514 children were examined in 206 villages, of whom 7,550 had enlarged spleens, giving a total spleen-rate of 55·9 per cent. In the Jessore district 5,147 children were examined with 3,205 enlarged spleens, giving a rate of 62·3 per cent.; in Nadia 3,623 children had 2,393 enlarged spleens, and a rate of 66·1 per cent.; and in Murshidabad 4,744 children had 1,952 spleens, a rate of 41·1 per cent. The high rate in Nadia is due to the inclusion of the Gangni thana, which was shown in the *interim* report on the Nadia district to have a very high spleen-rate due probably to Leishman-Donovan infection. If the Kumarkhali and Jibannagar thanas alone are taken, where Leishman-Donovan infection is apparently present in small amount only, and where the spleen-rates are almost entirely malarial, as in the Jessore and Murshidabad districts, the spleen-rate for the district would be 53·3, and Nadia would hold a place intermediate between Jessore and Murshidabad.

7. *Nature of the fever.*—As noted in the *interim* report for the Jessore district, 17 endemic indices were calculated on the basis of the examination of 644 specimens of blood from children under 12 years of age, collected in 25 villages during the latter half of October. The average endemic index was found to be 34. The following table gives the varieties and relative frequency of the malarial parasites found:—

Malarial Parasites found in 644 blood specimens.

Type of parasite.	Number found.	Percentage.
Malignant tertian	158	69 per cent.
Benign tertian	46	20 ,,
Quartan	25	11 ,,
Total ...	229	100

Mixed infections occurred in eight specimens.

From the high average endemic index obtained, there is no doubt that the prevalent fever of the country is malaria, and the index is sufficiently high to account for the spleen-rates found. During the examination of these 644 specimens of blood no other varieties of parasite, such as Spirilla or Filariæ, were found. The endemic indices were shown to vary very constantly with the spleen-rates found, and after this was demonstrated the spleen-rate alone was used in comparing the relative amount of malaria in different villages, both on account of the large amount of time necessary for taking endemic indices, and because they can only be used to compare villages examined at about the same time of year. The only likely source of error in using spleen-rates in this way was the possibility of infection by the Leishman-Donovan body being present in large amount throughout the districts. This disease with our present knowledge can only be definitely diagnosed by spleen puncture or by accurate observations in hospital, but at the same time advanced cases present a fairly definite picture. There is great emaciation of the body and limbs, large protuberant abdomen, extremely large and hard spleen, and enlargement of the liver, sometimes down to and below the umbilicus. Oedema of the feet and hands and *cancrum oris* occur frequently in the later stages, and scars of old *cancrum oris* may be seen in cases which are recovering. The condition is quite different from the usual type of malarial cachexia. As the disease is a chronic one, such cases ought to have been common, if the disease was at all prevalent in the districts examined. A few were seen in all parts of the districts with the exception of the Gangni thana in Nadia, where there were many. This has been already referred to in the Nadia district report. On this account the villages of the Gangni thana are not included in this report when comparing the spleen-rates of villages Altogether cases of Leishman-Donovan infection were seen in 42 villages; in Gangni they were seen in 17 out of 18 villages examined, and in the remainder of the districts in 25 out of 188 villages, of which three were very doubtful cases. Spleen puncture was carried out in two of these advanced cases of Leishman-Donovan disease ; one was positive and the other negative. More spleen punctures were not done on account of the element of risk involved and the difficulty in obtaining hospital accommodation.

It may be concluded therefore that while the disease does exist in most parts of the districts (the villages in which cases were seen are noted in the *interim* reports of each district), it is only present in small amount, and that the spleen-rates are reliable as a test for malaria.

It may be noted here that in most parts of the districts the inhabitants stated that fever had been very prevalent for many years, twenty to thirty as a rule. In the Gangni thana it was stated to have been bad for only the last five or six years, which would appear to indicate that the infection by Leishman-Donovan disease dated from that time or a little previously.

8. *Immunity from malaria.*—It has been stated that in countries which suffer much from malarial fevers, adults acquire by frequent attacks in childhood a certain immunity from the disease. This appears not to be the case in these districts, or at any rate to only a very small extent. As will be seen later in discussing the mortality, malaria is responsible for a large proportion, about 26·5 per cent., of the deaths among adults which are registered as fever. Altogether 417 adults were examined in various parts of the three districts, of whom 204 or 49 per cent. had enlarged spleen. The children's spleen-rate for the districts was 55·9 per cent. If immunity was acquired to any considerable extent, both the adult mortality and the spleen-rate would probably be much less.

9. *Mortality due to malaria.*—In the three districts histories of the illness was obtained from relatives of 835 persons who had died during the last two years and whose deaths had been registered as "fever." The following table gives an analysis of the results with the monthly incidence.

Analysis of 835 "fever" deaths with monthly incidence.

MONTH.	Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and Diarrhœa.	Typhoid.	Born feeble.	Leishman-Donovan infection.	Other causes.	Doubtful.	Total.
January	15	15	15	9	9	18	3	8	3	20	7	117
February	7	6	3	4	4	4	1	...	1	5	4	39
March	6	7	8	2	5	8	...	...	2	5	7	50
April	6	11	5	1	2	3	1	1	1	11	4	46
May	5	4	4	...	1	3	...	...	...	6	7	39
June	8	9	3	1	2	4	...	...	1	5	7	40
July	7	13	4	2	2	2	4	1	3	13	4	55
August	20	17	4	5	8	9	1	1	...	7	7	79
September	19	10	1	2	4	11	3	2	...	10	6	68
October	21	12	7	1	8	11	2	2	4	16	10	94
November	24	12	4	5	6	12	4	2	...	12	5	68
December	26	22	12	9	12	18	2	1	5	18	6	131
Total ...	164	138	70	41	63	103	21	13	20	128	74	835
Percentage of "Fever" deaths	19·6	16·5	8·4	5·0	7·5	12·3	2·5	1·6	2·4	15·3	8·9	100

From this table it aprpears that acute and chronic malaria together are responsible for 36·1 percent., or rather over one-third of the deaths registered as "fever." The seasonal incidence begins to rise with the onset of the rains, continues to increase through the autumn, and is heaviest in December. Phthisis is responsible for 7·5 per cent, and dysentery and diarrhœa for 12·3 per cent. of the "fever" deaths. These figures however do not represent the total mortality due to these diseases, as probably some of the phthisis deaths are registered under "other causes," and a small proportion of deaths from dysentery and diarrhœa are registered under their own proper heading. Persons much debilitated by malaria appear to be predisposed to such diseases as phthisis, dysentery and diarrhœa, so that probably many deaths ascribed to these diseases are primarily due to malaria Leishman-Donovan infection appears to be responsible for 2·4 per cent. of the fever deaths. The rate is probably lower than this in all parts examined of these districts, except in the Gangni thana of the Nadia district. In this thana there were 11 deaths from Leishman-Donovan infection out of 66 "fever" deaths, giving a percentage of 16·6. In the remaining parts of the districts there were 9 deaths out of 769 "fever" deaths, giving a percentage of 1·2 due to Leishman-Donovan infection.

10. As regards the age incidence of the "fever" deaths enquired into, the results are tabulated below:—

Table showing the age incidence of 835 "fever" deaths, classified according to the table in paragraph 9.

Age.	Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and Diarrhœa.	Typhoid.	Born feeble.	Leishman-Donovan infection.	Other causes.	Doubtful.	Total.	Percentage of "fever" deaths.
Under 1	14	1	5	3	...	6	...	13	...	6	4	52	6·2
1—5	59	28	7	1	...	31	1	...	2	13	16	158	18·9
6—10	16	29	1	3	2	6	1	...	9	8	6	81	9·7
11—15	8	12	...	...	4	4	3	...	2	5	5	43	5·2
16—20	7	11	1	6	8	3	3	...	4	8	10	61	7·3
21—30	15	17	4	4	21	13	7	...	3	20	6	110	13·2
31—40	17	18	8	9	14	11	5	...	...	12	9	103	12·3
41—50	14	11	2	5	13	10	1	...	...	9	7	82	9·8
51—60	8	9	17		...	8	...	...	...	17	8	75	9·0
Over 60	6	2	15	2	1	11	...	...	...	30	3	70	8·4
Total ...	164	138	70	41	63	103	21	13	20	128	74	835	100

This table shows that a large proportion, nearly half, of the deaths due to acute malaria occur in children under 5 years, and that about half of all the deaths due to acute and chronic malaria are under 10 years. While taking spleen-rates in these districts, 627 children of 1 year and under were examined, and of these 202, or 32 per cent., were suffering from enlarged spleen, *i.e.*, had probably had several attacks of malaria. The large infantile mortality due to malaria is not surprising when such a large proportion of infants are shown to have suffered repeatedly from the disease, especially when it is remembered that most of the cases are absolutely untreated. The difficulty in giving quinine to children owing to the taste renders it even less likely that they get efficient treatment than in the case of adults. Out of 291 "fever" deaths in children under 10 years of age, 89, or 30·6 per cent., were due to acute malaria, and 58, or 19·9 per cent., to chronic malaria. In the case of adults over 20, out of 440 "fever" deaths, 60, or 13·6 per cent., were due to acute, and 57, or 12·9 per cent., to chronic, malaria. Therefore while the proportion of the "fever" deaths due to malaria is greater in children than in adults, still there is a large mortality among adults directly from malaria, and that this is so must be attributed solely to the fact that they do not get efficient treatment with quinine, as among persons properly treated, malaria is not a fatal disease except in a small proportion of cases.

The diminished birth-rate in these districts is also to be attributed at any rate in part to the great prevalence of malaria, acting both by causing abortion or still-birth, and by lessening the reproductive powers in persons debilitated by continued attacks.

11. *Local conditions affecting the prevalence of malaria.*—

(*A*) *Village sanitation.*—A description of the usual village conditions was given in the Jessore *interim* report, and is applicable to all the three districts visited. In addition to the bad internal conditions of the villages, in many parts rice cultivation is carried on in the immediate vicinity of the village or even between the houses. Anopheles mosquitoes were found breeding in the rice-fields during October and November, and there is little doubt that these are a source of danger. Unless regulations prohibiting rice cultivation in or near villages are introduced, it would tend to nullify any anti-mosquito measures carried out in the villages.

The following table is a summary of the three tables in the *interim* reports, showing the effect of the amount of jungle present on the malaria of the villages:—

Table showing the relation of jungle to malaria.

Amount of jungle.	Number of villages examined.	Average spleen-rate.
Thick	97	68·8
Moderate	47	48·1
Little	26	26·2

This table shows very strongly the influence of thick jungle in the villages. The explanation of its evil effects lies in the slow drying up of the soil and evaporation of the surface collections of water in pits and hollows, which remain for a long time as breeding places for mosquitoes; in the shelter afforded from the sun to the larvæ breeding in these pools; and in the protection from sun and wind to the adult mosquitoes. Where the jungle is thick, it prevents access of sun and breeze to the houses, and its use as a latrine by the members of the household leads to an extremely insanitary state. The difficulty in destroying the jungle in the villages lies in the rapidity with which it grows up again, and is only to be got over by encouraging dry cultivation in these places. As soon as the villagers appreciate the value of the land in the villages they will keep the cultivation going by themselves.

(*B*) *Influence of situation.*—With the object of ascertaining the influence of situation on malaria the average spleen rates of villages situated on live and dead rivers, in bheels, and on dry land, are compared in the following table:—

Table showing the relation of situation to malaria.

Situation.		Number of villages examined.	Average spleen-rates.
River	Live	33	46·0
	Dead	38	64·5
Bheel		56	62·2
Dry land		45	45·6

The villages of the Gangni thana in the Nadia district are omitted for the reasons given in paragraph 7.

From this table it appears that villages on live rivers and villages on dry land are practically equally healthy, and are less unhealthy than those on dead rivers and bheels. The latter may be taken as the situations where there are signs of imperfect drainage, and their comparative unhealthiness is to be attributed to the greater amount of water affording breeding places for mosquitoes in the neighbourhood of the villages, and to the obstruction of the natural drainage resulting in a retardation of the drying up of surface collections of water. From the list of villages appended to the *interim* reports, it will be seen that villages in these different classes vary much in their individual spleen rates, so much so that it is difficult to believe that the situation is the primary factor in the causation of malaria.

Taking the classes in turn, the spleen rates of villages on live rivers vary from 0 to 81; on dead rivers from 15 to 92; on bheels from 6 to 91; and on dry land from 5 to 98. In the *interim* reports certain specific cases of marked differences between villages of the same class situated close to one another and comparable in every other way have been shown to be attributable to the varying amount of jungle present. At the same time there are many cases where the cause of the difference is not apparent; a good example is the three villages on the Telkar bheel in the Murshidabad district to the west of the Bhagirathi river, which have the low spleen rates of 6, 6, and 11, while four villages on bheels immediately across the river vary from 72 to 87; or again in the case of villages on live rivers, Sondah on the Gorai river in the Nadia district has a spleen rate of 38, while an adjoining village, Burulia, on the same river has one of 74, though their situation, water-supply and amount of jungle present were the same.

(*C*) *Influence of subsoil water.*—In the examination of the villages, observations were made on the subsoil water level in the wells at the time of visit and after the rains. No connection is apparent between the height the water rises to in the rains and the spleen rate. In Jessore the high rates were in the villages with highest subsoil water level, but the opposite was the case in the Murshidabad district. In Murshidabad there appeared to be some connection between the spleen rates and the rapidity of fall in the subsoil water level, the villages with the greatest fall since the rains having the lowest average spleen rates. The same, to a less marked degree, was found in the Kumarkhali and Jibannagar thanas of Nadia. In the Jessore district most of the villages which had wells were examined too soon after the rains to estimate the rapidity of the fall. This method of course can only be used to compare spleen rates of villages examined at approximately the same time. It is probable that a rapid fall in the subsoil water level would tend to hasten the drying up of the surface collections of water and so to decrease malaria. In this way areas with good natural subsoil drainage would be healthier than others in which the subsoil water remained high for a long period after the rains; and any measures tending to accelerate the fall of the subsoil water in a given tract would be likely to improve the conditions as regards malaria. As far as our knowledge goes at present, there is no reason to believe that the subsoil water has any connection with malaria except in so far as it is a cause of surface collections of water, or retards their drying up.

12. *Mosquitoes.*—Anopheles *Fuliginosus* and *Barbirostris* are the most common varieties of anopheles found in these districts. The former was found in large numbers in houses, cowsheds, etc., in all parts of the three districts throughout the cold weather. Only one *Barbirostris* was caught in a house. Larvæ of both these varieties were found breeding everywhere in large numbers in weedy tanks, ditches, and pools, at the edges of bheels and marshes, and in rice fields, all through the cold weather. Sporozoits of malaria were found in one specimen of *Fuliginosus* caught in Jessore town. Anopheles *Rossi* were found fairly numerous in houses in the Jessore district in October, November, and December, and in the Murshidabad district in February. Their larvæ were found breeding in the marshy ground at the sides of rivers and ponds up to the end of October. Anopheles

Listoni were found fairly common in houses in the Jessore district in November, and a few in the Nadia district in January. Anopheles *Jamesi* were found common in houses in the Jessore district in November. A few Anopheles *Culicifacies* were found in houses in the Murshidabad district in February. One specimen believed to be Anopheles *Turkhudi* was found in a house in the Magura subdivision of the Jessore district in December.

13. *Conclusions.*—It has been shown that malaria is extremely prevalent in all these districts, and that there is a large mortality, both among children and adults, actually due to malaria. It has also been shown that the amount of jungle, the situation of the villages, and possibly the rate of fall of the subsoil water have each an influence on the malaria in the villages. There seems little doubt, however, that the main factor in the causation of malaria in these districts is the extremely insanitary conditions of the villages themselves, the thick jungle, large nuimber of tanks, pits and surface collections of water; the bad drinking water-supply; the absence of latrines; and in many villages the cultivation of rice in close proximity to the houses. These village conditions are no doubt met with in other districts where malaria is not so prevalent, but it is the combination of them with the water-logging of the soil in these districts, as shown by the high subsoil level in wells, and the numerous marshy tracts and *bheels*, that renders them unusually maleficent; and it is here that the influence of situation has its effect. Villages situated in *bheel* lands and on dead rivers have been shown to have a higher average spleen-rate than in other situations, and this is owing to the fact that in these situations the natural drainage is imperfect on account of the insufficient fall in the levels of the country, and consequently there is a high subsoil water level, a low rate of fall in the subsoil water after the rains, and a waterlogging of the soil. This waterlogging of the soil, however, can only act by keeping all the surface collections of water in the villages full for a long period after the rains, and if the sanitary conditions of the villages were improved, the effect of the water-logging would be reduced at the same time.

14. *Remedial measures.*—The main cause of malaria and the condition most urgently requiring attention is the village sanitation. Without taking steps towards its improvements, it is probable that other schemes for lowering the subsoil water, draining *bheels*, and increasing the flow in rivers, will show but small result. Each village has innumerable breeding-grounds for mosquitoes close to the houses, most of which would not be touched by these projects for improving the surroundings of the villages. It is not to be expected that the villages of Bengal can all be turned into model villages immediately, but much can be done gradually, especially if the co-operation of the zamindars can be obtained. A few villages, here and there, as object-lessons, would form useful experiments as to the value of the measures taken, and if successful, would go far to obtain that co-operation.

The actual measures recommended have been mentioned shortly in the *interim* report on the Jessore district, and do not require repetition. The question of rice cultivation in the neighbourhood of the villages is a very difficult one; there seems little doubt that it is harmful, and that only dry crops should be permitted near the houses. It is hopelessly antagonistic to any anti-malarial measures directed against the breeding of mosquitoes in the villages, as any good effect would be counterbalanced by increased breeding in the surrounding rice-fields. Unless cultivation of only dry crops near the villages be permitted, anti-mosquito measures are useless and a waste of money, and the use of quinine, more freely, is the only remedy under the circumstances.

With regard to other measures, the draining of *bheels* is likely to do good, if the water can be got off the land as early as possible after the rains; if it is to be kept on the land artificially for the purpose of rice cultivation until the middle of November, and then drained off, the greater part of the good will be lost. Nearly all the fresh infections of malaria occur before that time, and the damage has already been done.

The improvement of the dead rivers, by bringing more water into them at their heads from "feeder" rivers, appears of doubtful benefit. Some good may be done in this way by the improvement of the river as a source of drinking-water for a short time after the rains, but in the majority of cases it will not be possible for the increased flush to be continued all through the year, and in the dry weather the river would sink back to its old stagnant condition. By bringing more water into the river its level will be raised, and the already obstructed drainage from the surrounding country will be still more obstructed. The draining of *bheels* into the dead rivers will increase somewhat the flow in them, but probably not sufficiently to prevent them acting as breeding-grounds for mosquitoes, as undoubtedly they are to some extent at present. In suitable instances it may be possible to hasten the silting up of *bheel* areas by letting in flood water full of silt from the main rivers.

The possibility of lowering the subsoil water level is a question for the engineers; it may be stated generally that any measures which will lower the level or accelerate its fall after the rainy season are likely to be of value by assisting the drying up of the surface collections of water.

While these measures for the improvement of sanitation are all likely to be of value in reducing the amount of malaria in the country, it is impossible to rely upon them entirely. Such experiments as the Mian Mir one in the Punjab have proved the great difficulty in obtaining good results even where much money has been spent and careful supervision exercised.

It is necessary to encourage the use of quinine amongst the villagers in every way possible. The establishment of travelling dispensaries under reliable Hospital Assistants to tour through the country during the whole year would probably be of great value. It would be necessary for them to work during the whole year, and each to have a definite weekly tour, so that the confidence of the villagers would be gained and the inhabitants of the outlying villages would know exactly on what day the dispensary would be at each village. Unfortunately, there appears to be a prejudice against the use of quinine among many of the villagers, due probably to its use in insufficient doses or else without a preliminary purge. Instructions as to this might be printed on the packets of quinine sold at the post-offices, and also a more palatable form might be introduced for the use of children, if it can be obtained sufficiently cheap.

The value of sanitation, the prophylaxis of malaria by the use of quinine and mosquito curtains, and the efficient treatment of malaria by quinine are matters which might well be taught in all schools.

In dealing with the present large mortality due to malaria, there are many obstacles and difficulties in the employment of the measures which have been indicated in the preceding paragraphs, and their effect is in some cases doubtful. Drainage of the *bheels* will probably do good, but to what extent can only be ascertained by experiment. The opening up of the heads of dead rivers does not appear to offer any likely advantages. The cutting of jungle and the improvement of sanitation in the village, if it can be thoroughly done, will doubtless do much good, but it requires a great deal of supervision, heavy expense and the co-operation of the zamindars and villagers to an extent which in their present state of apathy and ignorance it would be hopeless to expect. Prophylaxis by quinine is impracticable at present. We are of opinion, taking into consideration the type of people and country to be dealt with, that by encouraging the use of quinine and facilitating the treatment of the sick, more benefit will accrue and at a less cost than by schemes for drainage and sanitation, though that is no reason why these should not be carried out as well. The disease is essentially a curable one, and the present excessive mortality is attributable to the want of efficient treatment in the vast majority of cases.

15. In conclusion, we wish to express our thanks to the Magistrates and Civil Surgeons of the Jessore, Nadia and Murshidabad districts, and to all the officials under them, for their kind assistance at all times during this enquiry.

CALCUTTA,
The 15th March 1907.

G. E. STEWART, CAPT., I.M.S.
A. H. PROCTOR, LT., I.M.S.

INTERIM REPORT ON THE JESSORE DISTRICT.

This enquiry was carried out in connection with the Committee appointed to investigate the prevalence of malaria in the Presidency Division. In October 1906, Captain G. E. Stewart, I.M.S., and Lieutenant A. H. Proctor, I.M.S., proceeded to the Jessore district, with instructions from the Sanitary Commissioner for Bengal to ascertain, as far as possible, (i) whether the reported prevalence of "fever" was correct; (ii) what proportion of the "fever" cases were actually malarial in origin; (iii) what proportion of the reported death-rates were due to malarial fever or its results; and (iv) what practical remedial measures could be suggested, with special regard to drainage, particularly to the drainage scheme already proposed for the Bhairab valley.

2. The investigation was carried on during the latter half of October, the whole of November and the first half of December, the time of the year during which the fever is at its maximum, and the Sadar, Jhenida, Magura and Narail subdivisions were visited.

In each subdivision special villages were selected for examination, the selection being guided by reports from the Collector and the Subdivisional Officers as to the most healthy and most unhealthy villages in their jurisdiction, or else because the localities chosen were typical as regards position on the banks of rivers, in the middle of bheels, or at some distance from either, and so affording evidence of the relative healthiness of the different situations.

3. The examination in each village was carried out mainly on the following lines:—

(1) As many children as possible were examined for enlargement of the spleen to ascertain the spleen rate, *i.e.*, the percentage of children with enlarged spleen.

(2) In certain villages blood specimens were taken and an endemic index obtained, *i.e.*, the percentage of children in whose blood malarial parasites were present. This was only done in sufficient numbers to show that there was a definite ratio in this district between the spleen rate and the endemic index, and was then abandoned, as it cannot be used to compare the relative amount of malaria in different villages unless they are all examined at the same time of year. The endemic indices and spleen rates in this report were obtained from children under 12 years of age. The children were usually obtained by house-to-house visitation so as to obviate any selection being exercised by the chaukidars or parents in assembling the children. In the cases where owing to want of time or for any other reason they had to be collected, special instructions were given to the collectors to bring all the children from each household, and there is no reason to believe that these instructions were not carried out. It may be mentioned that in the villages the parents raised no objections to their children being examined, nor was there any difficulty experienced in getting specimens of blood where they were wanted.

(3) Relatives of persons who had died recently in the villages and whose deaths had been registered as "fever" were questioned as to the nature of the illness with a view to obtaining, if possible, an accurate diagnosis of the case, and so ascertaining what proportion of the deaths registered as "fever" were actually due to malaria. This method was not found to be very reliable. Clear histories justifying a definite diagnosis of malaria were the exception, and in most cases all that could be said was that the history did not show definitely any other disease, that fever was present, and that it was possibly due to malaria—a negative and probably very inaccurate method of diagnosis, but still affording some evidence of the mortality directly due to malaria.

(4) In those places where there were wells the height of the subsoil water was noted with a view to ascertaining whether those places were most malarious where the subsoil water level was highest.

(5) Notes were taken of the general sanitary conditions of each village and its surroundings.

(6) In certain places the varieties of anopheles mosquitoes present and their chief breeding places were noted.

4. *Character of the country visited.*—The whole district in which the enquiry was carried out may be roughly divided into two portions—(1) that to the north and east in which the rivers are not much silted up, are clear of weeds, and have a good flow throughout the year. These rivers are principally the Kumar, Gorai, Madhumati and the portion of the Nobogunga below Magura and of the Chitra in the Narail subdivision; (2) that to the west and south intersected by the upper portion of the Nobogunga, by the Chitra and the Bhairab, all of which are much silted up and blocked with weeds, and in dry weather become merely lines of stagnant pools. The areas lying between these rivers are for the most part bheel lands, some connected with the rivers by khals and regularly flushed out at flood times; others connected by khals which have partially silted up so that a flush is only obtained at the time of unusually heavy floods; and again others unconnected with rivers, in which the

rain-water and drainage from the surrounding country lies stagnant for the greater part of the year. The two latter varieties are found chiefly in the western and southern parts of the district, giving evidence of the general lack of drainage in this part, due to the gradual heightening of the river beds usual in deltaic tracts. In the north-eastern part the bheels are mostly covered with water at the end of the rains, but owing to the better drainage dry up rapidly and more completely, leaving fewer marshes and stagnant collections of water than in what may be called the silted-up area.

5. *Prevalence of "fever."*—The prevalence of enlarged spleens among children may be taken as a good guide in estimating whether there is a large amount of "fever" in a country or not; enlargement of spleen in adults is not reliable, as in a country where there is much "fever" some immunity may be acquired during childhood. During this enquiry 5,147 children were examined for enlarged spleen in 93 villages scattered throughout the four subdivisions. The average spleen-rate obtained in these villages was 65; in some it was more than 90. A list of villages with their spleen-rates is given at the end of this report, as also a map showing by colours the spleen-rates obtained and the position of the villages, from which it will be seen that high spleen-rates were found in all four subdivisions and were not localized in any particular part of the district. From this high general spleen-rate there is no doubt that "fever" is very prevalent in the whole district.

6. *Nature of the "fever."*—It remains to be shown whether the prevalent "fever" is malarial. For this purpose endemic indices as well as spleen-rates were taken in certain villages, all examined at nearly the same time of year. Altogether 644 blood examinations of children under 12 years of age were made for this purpose in 25 villages. In some cases where sufficient children were not obtained in one village, the specimens of adjoining villages, similarly situated, were taken together to form one endemic index for the group, so that in all 17 endemic indices were calculated.

The results found are given in the following table:—

Village.	Spleen-rate.	Endemic index.
Jessore	83	34
Chowgacha	25	8
Muktadaha	70	47
Patee Billa	57	20
Ichapur	56	50
Chiramankati	30	22
Chhatimtolla	37	11
Mandalghati	88	38
Chanchra	67	33
Singhia	62	29
Bassundia		
Sadullapur		
Khiphatnagar		
Jaghanathpur	73	36
Sheikhati	73	37
Ghuli		
Hamidpur	87	45
Boalia		
Narendrapur	90	49
Jirat		
Hatbila		
Ghoragacha		
Moheshpur	62	35
Jhenida	89	39
Poobhattie	70	37
Average ...	66	34

From this table it is seen that, in the villages mentioned, on the average out of every 100 children examined, 66 suffered from enlargement of the spleen, and 34 actually had malarial parasites in their blood. With one exception there is a remarkably constant proportion between the spleen-rates and the endemic indices, a high endemic index being accompanied by a high spleen-rate and a low one by a low spleen-rate, affording strong evidence of the one being dependent on the other. In the one exception, Ichapur, the spleen and endemic rates were nearly equal; this village was examined immediately after heavy rain, and possibly there may have been a rise in the endemic index caused by chills bringing on acute attacks of malarial fever in a large proportion of the children. In any case it affords no contrary evidence to the theory that enlargement of the spleen in this district is usually due to malaria.

7. The endemic indices obtained are quite sufficient to account for the high spleen-rates, but the possibility of the presence in large amount of Leishman-Donovan infection, the "cachectic fever" of Major Rogers, I.M.S., has to be borne in mind as a possible source of

error. This disease certainly does occur in the district, but, in our opinion, is comparatively uncommon. In advanced cases, which, as the disease is a chronic one, would be numerous if it was at all widespread, it presents a sufficiently definite clinical picture, though even then it is difficult to distinguish it from certain types of malarial cachexia except by spleen puncture or by accurate observations on the case in hospital, and these means were rarely available. In two cases spleen puncture was performed. One of these showed a scanty infection with Leishman-Donovan parasites, the other was negative. Spleen punctures were not carried out in more cases, after the existence of the disease in the district had been demonstrated, owing to the element of risk involved and the difficulty of obtaining hospital accommodation. A few other cases resembling the advanced stages of "Leishman-Donovan" infection were seen, chiefly in the north and east of the district, but not sufficient to make it probable that the disease is so prevalent as to cause any appreciable effect on the death-rate or to render the spleen-rates unreliable as a guide in estimating the amount of malaria present. The possible cases of "Leishman-Donovan" infection were seen in the localities given in the following table :—

Subdivision.	Village.	Number of cases.	REMARKS.
Sadar ...	Jail	1	Spleen puncture negative.
Narail ...	Narail	1	Ditto positive.
Jhenidah	Baloohar	2	
	Bootirghati	2	
	Khajura	1	
	Kalicharanpur	1	
	Narayanpur	1	
	Attarkhada	2	
Magura	Katoli	1	
	Amalshahar	3	
	Benodpur	1	
Total ...	......	16	

At Amalshahar mentioned in the above table, a local medical practitioner, a graduate of the Calcutta University, had made special observations on the fevers of the district, and was able to obtain for us histories of 10 persons who had died during the last eight years in Amalshahar and the villages in that part of Magura subdivision with symptoms of "cachectic fever." These 10 cases had occurred in six families, one household supplying three cases, and two households two each, showing the usual tendency of the disease to attack several occupants of one house. The occurrence of only 10 deaths in a large area during a period of eight years shows that the disease is comparatively rare.

8. It may be concluded therefore that enlargement of the spleen is in this district due to malaria in all but a very small proportion of cases, and may be taken as a basis in estimating the malarious nature of the country and the relative prevalence of the disease in different villages. The spleen-rate of the whole district was found to be 62, or in other words 62 children out of every 100 had suffered from repeated attacks of malaria, sufficient to prove without doubt that the country is extremely malarious. The question of the differences in spleen-rates obtained in different villages will be discussed later in connection with the effects of local conditions on malaria.

Adult spleen counts were taken in a few places, and compare as follows with the children's rate for the same places :—

	Adult spleen-rate.	Children's spleen-rate.
Jessore Municipality ...	68	83
Ichapur ...	12	56
Mandalghati ...	39	88
Basundia ...	33	87
Hamidpur and Baolia ...	65	87

From this it would appear that there may be a certain amount of immunity among adults.

9. *Mortality due to malaria.*—As stated before, an attempt was made to determine what proportion of the deaths registered as "fever" was actually due to malaria, in the way adopted by Major Rogers, I.M.S., in his report on the fevers in the Dinajpur district, viz., by obtaining from the relatives of the deceased persons a history of the illness and so separating

out the malarial cases from the very mixed bag which goes in under the term "fever" in the registration returns. The histories obtained were too indefinite to make this method a basis for accurate statistics on the subject, and even had it been found possible to diagnose the deaths directly due to malaria, the results would give but a small idea of the ravages caused by a disease which is so prevalent, and which by weakening the vitality of those attacked by it and by complicating other diseases must be indirectly a causative agent in a large proportion of deaths ascribed to other diseases. However, the method is probably sufficient to show that there is a large mortality due directly to malaria. Altogether information was gathered concerning the deaths of 398 persons, which had been registered as "fever," and an analysis of the cases with the monthly incidence is given in the following table. The cases were taken from the whole area covered by the enquiry, and so are representative of all the district. There did not appear to be any marked difference in the proportion of deaths due to malaria in different localities:—

Analysis of 398 deaths registered as "fever" with monthly incidence.

MONTH.	Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and Diarrhœa.	Typhoid.	Born feeble.	Leishman-Donovan.	Other causes.	Doubtful.	Total.
January	7	2	...	2	5	4	1	1	1	9	1	33
February	3	5	1	2	2	1	...	...	...	2	1	17
March	2	5	5	1	3	3	...	...	...	3	6	28
April	4	2	2	...	1	1	...	1	1	7	3	22
May	2	2	3	...	1	3	...	...	...	5	6	22
June	6	3	1	...	1	1	...	...	...	5	5	22
July	1	4	3	2	...	2	1	...	...	6	3	22
August	9	8	2	3	6	4	1	...	...	4	2	39
September	8	5	1	...	1	6	...	1	...	3	6	31
October	10	6	4	1	5	5	...	1	1	11	4	48
November	14	8	2	3	6	7	3	...	...	7	5	55
December	14	9	4	5	5	8	1	1	1	7	4	59
Total ...	80	59	28	19	36	45	7	5	4	69	46	398
Percentage of "fever" deaths.	20·1	14·8	7·0	4·8	9·0	11·3	1·8	1·3	1·0	17·3	11·6	100

From this it is seen that acute and chronic malaria are together responsible directly for about one-third of the total deaths registered as "fever." The seasonal incidence of malaria is heaviest as might be expected towards the end of the rains and in the early part of the cold weather, that is, at the time when the country is drying up, and the pools and marshes which afford breeding places for mosquitoes are most numerous, and when chills causing recrudescences of malarial attacks are most likely to occur.

Phthisis is responsible for 9·0 per cent. of the deaths registered as "fever," and dysentery and diarrhœa for 11·3 per cent. These figures, however, do not represent the total mortality due to these diseases, as some cases of phthisis are probably returned under the heading "other causes" in the registration returns, and a small proportion, roughly 1 in 60 cases, of dysentery and diarrhœa is returned under its own proper heading. It is well known that malaria and the lowered vitality resulting from it is a predisposing cause in these two diseases, phthisis and dysentery, so that probably it is responsible in part for their prevalence and for the mortality ascribed to them.

Leishman-Donovan infection caused 1 per cent. of the "fever" deaths. This disease is difficult to separate from chronic malaria by this method of enquiry, but it does not appear to be common in this district.

10. The death-rate per 1,000 registered as "fever" and the actual rate due to malaria, calculated on the basis of the results obtained in the preceding table, are shown below for the last five years for the district of Jessore and for the four subdivisions included in this enquiry:—

Deaths per 1,000 from "fever" and from malaria.

	1901.		1902.		1903.		1904.		1905.		Average of 5 years.	
	"Fever."	Malaria.	"Fever."	Malaria.	"Fever."	Malaria.	"Fever."	Malaria.	"Fever."	Malaria.	"Fever."	Malaria.
Sadar	27·2	9·1	30·5	10·2	31·1	10·4	33·0	11·0	32·9	11·0	30·9	10·3
Jhenida	25·8	8·6	37·2	12·6	32·5	10·8	34·7	11·6	35·1	11·7	33·1	11·0
Narail	25·9	8·6	37·2	12·6	27·3	9·1	32·5	10·8	30·7	10·2	30·7	10·2
Magura	27·4	9·1	35·9	12·0	35·3	11·8	39·6	13·2	32·2	10·7	34·1	11·4
Jessore district	27·0	9·0	34·5	11·5	31·3	10·4	33·9	11·3	33·0	11·0	31·9	10·6

From this it is seen that the average death-rate directly due to malaria in the Jessore district is about 10·6 per 1,000; that is, about 19,000 or 20,000 persons die annually of this disease alone in the district.

An interesting point in this table also is the fact that while all the four subdivisions examined are affected by the high malaria rate, the worst is Magura subdivision, with an average rate of 11·4 per 1,000. The general impression amongst the inhabitants of the Jessore district was that the Jhenida subdivision and the Sadar subdivision were the most unhealthy, and this is endorsed by the Magistrate of Jessore in his letter to the Drainage Committee, dated 9th September 1906. Narail is reported to be the most healthy, and this is borne out by the figures, but the difference is almost negligible, 0·1 per 1,000 less than the Sadar subdivision. In the same letter the Magistrate of Jessore states that Magura and Narail subdivisions used to be quite healthy 15 or 20 years ago, and that even 10 years ago Narail was quite free from malaria, but the Sanitary Commissioner for Bengal in his report for the year 1876 includes Narail thana amongst the most unhealthy areas, and in 1877 states that fever was epidemic in Narail in October. In 1890 Narail heads the list in the Jessore district for fever. It is probable, therefore, that malaria is nearly equally prevalent in all the subdivisions taken as a whole. The impression that the Magura and Narail subdivisions are much healthier than the others has probably been derived from the fact that certain important centres, such as Magura, Nohatta and Narail towns, which are situated actually on the banks of live rivers, are comparatively healthy, and no notice has been taken of the villages lying further away from the rivers. This question will be considered again later in connection with the local conditions as affecting malaria.

11. *Age incidence of principal diseases*—

Age.	Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and Diarrhœa.	Typhoid.	Born feeble.	Leishman-Donovan.	Other causes.	Doubtful.	Total.	Percentage of "Fever" deaths.
Under 1	4	...	1	...	...	2	...	5	...	1	4	17	4·3
1— 5	32	12	2	1	...	13	...	...	1	7	12	80	20·1
6—10	5	13	...		2	2	1	...	...	4	3	31	7·8
11—15	4	3	...	...	4	3	1	...	...	1	2	18	4·5
16—20	6	4	1	4	3	2	1	...	3	5	8	37	9·3
21—30	4	9	2	2	13	9	2	...	...	11	5	57	14·3
31—40	8	10	4	6	6	5	2	...	...	6	5	52	13·0
41—50	9	6	5	3	7	5	...	...	...	6	3	44	11·1
51—60	3	1	5	2	...	...	...	...	...	14	2	27	6·8
Over 60	5	1	8	...	1	4	...	...	...	14	2	35	8·8
Total ...	80	59	28	19	36	45	7	5	4	69	46	398	100

This table shows that about half the deaths due to malaria occur in children under 10 years of age, and by far the largest number due to acute malaria are under five years. Out of 128 deaths of children under 10 registered as "fever," 41 or 32 per cent. died of acute malaria, and 25 or 19·5 per cent. of chronic malaria. In adults over 20, out of 215 "fever" deaths, 29 or 13 per cent. died of acute malaria, and 27 or 12·6 per cent. of chronic malaria. Malaria does not form therefore so large a proportion of the "fever" deaths in adults as in children, but still there is a large adult mortality due to it. Dysentery and diarrhœa were responsible chiefly for deaths under five years. Phthisis was most common in middle life, pneumonia and bronchitis in middle and old age. Reference may here be made to the low birth-rates in the Jessore district, as compared with the average birth-rates in other districts of Bengal. There is little doubt that a prevalence of malaria has a prejudicial effect on the birth-rate, both by causing abortion and still-birth, and also probably by diminishing the reproductive powers in persons whose systems are weakened by continual attacks. It seems not unjustifiable therefore to conclude that the low birth-rate in a district, in which malaria is so rife as to cause enlarged spleens in 62·3 per cent. of the children on the average, is due, at any rate partly, to malaria, and would be improved by any measures tending to reduce that prevalence of that disease.

12. *Local conditions affecting the prevalence of malaria.* (*a*) *Village sanitation.*—The majority of villages in the district consists of a number of separate homesteads scattered over a large area, each homestead being occupied by several members of the same family. The houses are built of split bamboos raised on a mud plinth of varying height, and in close proximity to the dwelling-houses are the sheds for cattle, the houses and sheds usually enclosing a central courtyard. The whole village is embedded in a dense tangled mass of jungle and bamboo thickets, and through this run narrow paths winding in every direction. Beneath the thick undergrowth round each house lie countless numbers of pits from which earth for the plinths has been dug; during the rains and for long afterwards these are stagnant fœtid pools, full of rotting leaves and vegetable matter. No sun reaches them, so evaporation is slow, and they remain for months convenient places in which the female mosquito, heavy with her latest feed of blood in the neighbouring house, can lay her eggs, and swarms of larvæ find ideal surroundings for their growth. The adult mosquito too finds shelter during the day from sun and breeze in the shade of the jungle round the houses, and the more domestic species obtain a resting place undisturbed by smoke in the cowsheds alongside. To the inhabitants the jungle affords privacy in their households and probably some protection from cold breezes in the winter, but it is also a convenient latrine and the stench in some of the villages is overpowering. The drinking water-supply is generally extremely

bad. Villages on a river take it directly from the edges, generally at a spot which is used as a bathing ghat, while the banks in close proximity are made use of as a latrine. A few villages have tanks reserved for drinking purposes, but these are in a very small minority, and generally the tanks are used for all domestic purposes. Some villages have *kutcha* wells, but often these are not used for drinking purposes, either on account of religious scruples or because the water is not considered good, and the tank or river water is preferred. In the greatest number of villages there is no attempt at any provision for drinking water, and it is taken from the nearest bheel or from casual collections of water in the pits and ponds near the houses, most of which are filthy and stinking. In those parts of the country where jute is grown there are many ponds in and round each village, which are used for steeping and afford breeding places for mosquitoes. The rivers and tanks from which drinking water is obtained are also often used for steeping jute, and though this may not be a direct cause of malaria, it is probably injurious to health. This extremely insanitary condition of the villages is combined with a general water-logging of the soil, shown by the high level of the subsoil water where it could be estimated, and by the innumerable marshy tracts and bheels scattered all over the country, and it is to the combination of the two that the extreme prevalence of malaria must be attributed.

During the enquiry the amount of jungle in each village was noted as being thick, moderate or little, and the following table giving the average spleen-rates of each class speaks for itself; the villages classed as moderate or little have been included with one another, as there were too few of the latter to make them into a class by themselves :—

Table showing the relation of jungle to spleen-rates.

Character of jungle.	Number of villages examined.	Average spleen-rate.
Thick	62	71·7
Moderate and little	21	44·5

(*b*) *Subsoil water.*—A high subsoil water is generally supposed to have an influence in increasing the amount of malaria; its action is probably indirect and due to increased breeding facilities for mosquitoes. With a high subsoil water every depression of the ground is converted into a pond or marsh, and both these and the surface collections of water in pits and ditches after rain are unable to percolate rapidly into the soil, and remain as breeding places for mosquitoes for a greater length of time than would happen in a district with a lower subsoil water. During this enquiry the level of the subsoil water was noted in villages where wells existed, but as the subsoil water was sinking rapidly, a direct comparison is impossible between the villages examined early in the tour and those examined later. Where reliable information was obtainable as to the highest level which the water reached at the end of the rains, this was noted, and the results as given in the following table show a decided reduction in the spleen-rate where the subsoil water was lowest :—

Table showing the relation of subsoil water-level to spleen-rate.

Subsoil water-level.	Number of villages examined.	Average spleen-rate.
Under 6 feet	21	75·8
Over 6 "	6	55·8

(*c*) *Situation of villages.*—In the area of silted-up rivers there appeared to be a general impression amongst the inhabitants that the rivers had a direct prejudicial effect on the health of villages on their banks, and that these villages were more affected by fever than those situated away from the rivers. In the north-eastern parts of the district, that is, in the area of "live" rivers, the impression was exactly the opposite. For the purpose of ascertaining if these ideas were correct and showing what effect situation has on the average health of the villages, they have been classified according to their positions on rivers and on bheels. Villages on bheels practically in this district mean all villages away from the rivers, as if not actually on a named bheel they are on marshy ground with swamps and with casual collections of water all round at the end of the rainy season. The villages on rivers have been divided again into those on "dead" rivers and those on "live" rivers, and the villages on bheels have been subdivided according to whether the bheels are flushed out from rivers or are merely stagnant collections of rain-water and surface drainage with no connection with a river :—

Table showing the relation of village situation and average spleen-rates.

Position.		Number of villages examined.	Average spleen-rate.	
River	Live	17	45·4	58·1
	Dead	23	70·9	
Bheel	Flushed	36	66·0	72·7
	Not flushed	7	79·4	

The most striking point in this table, as might be expected, is the comparatively healthy state of the villages along the banks of "live" rivers. These villages are without exception situated on the high banks above the rivers, and their healthiness is to be attributed to the good local drainage ensuing from their position. This appears to influence merely a small strip of country on each side of these rivers, as the villages lying a little away from them are often very unhealthy. A good instance of this is seen in the Magura subdivision. The two villages of Satreejatpur and Benodpur on the banks of the Nobogunga have spleen-rates of 59 and 48 respectively, while in Rupdia and Dharamdaha close by, but away from the river, they are 91 and 86. In one village of this class, Singha, in Narail subdivision, 52 children were examined, and no enlarged spleens found. The village is situated on the Chitra river, about 8 miles below Narail. The river here is large, has a good current, and a tide with a rise and fall of several feet. The river bank is high, and the village stands about 20 feet above high tide level at the time it was seen. The amount of jungle present is moderate; there are many of the usual pits and hollows near the houses, but they were empty at this time of year (December). The country inland from the village was dry and cultivated, but was said to be covered with water at the end of the rains. Drinking water was obtained from the river; there were no wells or tanks. The villagers stated that there was a good deal of fever in the village. The village conditions are therefore favourable, but still not offering any very marked differences from several other villages on the same river, which had higher spleen-rates. Villages in the other three classes are much more unhealthy, the worst variety are those situated in or near bheels which are not flushed at all, and next come those on dead rivers. The difference in the average spleen-rates in these three classes is not great, and practically they may be taken to be equally unhealthy.

Vide list of villages at end of report.

More interest lies in the fact that among villages belonging to one class great variations in the spleen-rates are found. For instance, the villages of Kalinagar and Kaligachi in the Magura subdivision have a spleen-rate of 7 only, while Chakoolia, a few miles away on the same bheel, has one of 64. The difference is found, not in the situation of the village, but in its own internal conditions. Chakoolia is the usual type of village, surrounded with dense jungle shutting out all air and light, with much casual water in every direction beneath the trees and undergrowth. Kalinagar and Kaligachi lie in the middle of a bheel; there is much water lying about them; drinking water is taken from these dirty pools, but there is almost no jungle; the homesteads are built on separate mounds with broad open spaces between each, clear of all jungle and brushwood, only a few large trees on each mound. The ponds at the bases of the mounds lie exposed all day to the sun; they dry up more rapidly, and probably do not harbour mosquito-larvæ nearly so much as shady pools. Another example in the same subdivision is Baulia with a spleen-rate of 50. In the same bheel about one mile on each side of Baulia are Katoli and Rampur with rates of 90 and 84 respectively; Baulia is only slightly jungly, the other two are embedded in thick jungle.

A table has been given before showing the difference in average spleen-rates obtained in villages which are in thick jungle and those less densely wooded. It is evident from the map accompanying this report that there are great variations in the spleen-rates obtained in villages under practically similar situations as regards rivers and bheels, so much so that it is impossible that their malarious nature can be due chiefly to their positions. It has no doubt an influence, but only in so far as it affects the local drainage and so intensifies or diminishes the primary cause of malaria, *i.e.*, the insanitary conditions of the villages themselves.

13. *Mosquitoes.*—The immediate cause of the spread of malaria in villages is the prevalence of anopheles mosquitoes, and observations were made during this enquiry of the chief varieties present and their principal breeding places. The following varieties of adult anopheles were found in houses and sheds:—Anopheles Fuliginosus, Rossi, Jamesi, Listoni, Barbirostris, and one possibly Turkhudi. The most common variety was Fuliginosus, which was found in large numbers all over the district. Rossi and Jamesi were numerous in the Sadar and Jhenida subdivisions, but not in Magura or Narail. This was possibly due to the change in the weather which had become much colder before these subdivisions were reached, and this may have affected their breeding. Listoni was found in small numbers in Jessore town. Only one Barbirostris was found in a house, but from the number of its larvæ found all over the district it must be extremely common. One specimen believed to be Turkhudi was found in Magura, but was unfortunately lost by the swamping of a boat before it was accurately identified. In view of the fact that Fuliginosus was found in large numbers all over the district, it is interesting to note that sporozoits of malaria were found in one specimen caught in Jessore town; this variety of anopheles has only rarely been found infected in nature. Larvæ of Fuliginosus and Barbirostris were found breeding in large numbers in weedy tanks, ditches and pools, at the edges of bheels and marshes, and in rice-fields. Barbirostris was also found among the weeds at the edges of silted-up rivers, where there was practically no current. Rossi were found in dirty pools and in marshy grounds at the edges of the rivers. No larvæ were found along the edges of "live" rivers, such as the Kumar and the lower parts of the Nobogunga and Chitra, where there were no weeds and a good current. The edges of these bheels and "dead" rivers are therefore sources of anopheles, and have probably some influence on the malaria in the neighbouring villages, but the chief sources are the numerous dirty pools, marshes and tanks scattered about the villages in greater proximity to the houses and more convenient for the mosquitoes to use as breeding places.

14. *Conclusions.*—To sum up, the excessive prevalence of malaria in the district as a whole can be attributed directly to the great facilities afforded to the breeding of mosquitoes,

chiefly by the presence in and around the villages of jungle, dirty tanks, ditches, marshes and casual water in every direction, and to a lesser degree to the bheels and dead rivers acting in the same way in some cases. In its turn the presence of so much water in the villages is due in part to the carelessness and ignorance of the inhabitants, and in part to the want of natural drainage in the country owing to its position in a deltaic tract, where the process of land-building is still going on. The rivers are gradually heightening their banks and beds until the drainage is away from instead of towards them. The subsoil water is unable to drain away rapidly, remains long at a high level after the wet season, and prevents the soaking in of rain-water, resulting in casual collections of water remaining for long periods in every hollow, natural and artificial. It is the combination of these two factors, the high subsoil water and the jungly and insanitary condition of the villages, that results in so high a malaria rate. The pits, hollows and jungle in the villages would in themselves be insufficient to account for so great a prevalence of the disease were they not combined with the lack of natural drainage, which allows the surface collections of water to remain for so long a time; and on the other hand so far as our present knowledge goes, the high subsoil water has no connection with the disease except in so far as it is a cause of these surface collections of water. The silting up of the rivers is merely one sign of the lack of natural drainage, and apart from that is not in itself a cause of malaria to any large extent.

15. *Remedial measures.*—Following on what has been said it is evident that any general measures taken for reducing malaria, apart from the administration of quinine, must be directed either towards lowering the subsoil water generally or against the present insanitary conditions in the villages. How far the former is possible is a question for the engineers. It is probable that if it can be done it will have an effect on the malaria; but there is no doubt that much can be done for the second factor by improved sanitation, chiefly on the following lines:—jungle round the houses should be cut down letting in light and air. This has been done before, but it has always been permitted to grow up again: the villagers should be encouraged to use the land for dry cultivation, and when they find that it can be made to pay they will continue it. The jungle which is chiefly concerned is the low undergrowth; the bigger trees could be left if they are of value. Regulations should be enforced to prevent the indiscriminate digging of pits to get earth for house-plinths: one or two spots a short distance outside the village might be chosen from which earth would be dug, and there tanks might be formed for jute-soaking, washing, etc. The drainage of the villages should be improved by cutting surface drains, and the earth removed used for filling in existing pits and hollows. Marshy areas and ponds should be drained or filled up; if this is impossible, they should be dug out so as to form clear tanks free from grass and weeds, as these do not breed mosquitoes to nearly the same extent. The question of a good water-supply for drinking is important. Wells should be dug or tanks reserved for the purpose. The drinking water is probably not a direct source of malaria, but it is of other diseases, chiefly of the alimentary tract, which lower the general health and predispose to malaria. All unnecessary tanks should be drained or filled in as far as possible, and those that remain should be kept clean and free from weeds.

16. Turning from the village sanitation to the question of the bheels and silted-up rivers, these may be discussed in connection with the drainage scheme for the Bhairab valley now before Government. As stated before, the bheels and "dead" rivers are sources of mosquitoes, and therefore of malaria for the villages situated near them, though to a lesser degree than the casual water actually near the houses, as mosquitoes do not go further to lay their eggs than they can help, and breed less in open water than in weedy grass-grown waters. However, anything which will reduce their breeding in these bheels and rivers will have some effect on the malaria.

The present scheme for the Bhairab valley consists of straightening the bed of the river by cuts so as to improve the flow in it, and in making cuts from the neighbouring bheels and so giving a better flush in the river by bringing in an increased volume of water during and after the rains. First, as to the effect on the bheels. Unless the water can be drained off by about the middle of November at latest there will be little improvement on the present state of affairs, as the breeding of mosquitoes and fresh infections in man ceases to a large extent with the onset of the cold weather. Malarial attacks after that time are generally due to recurrences in persons who have suffered previously. If, however, the bheels can be drained at an earlier date, there will be probably some decrease in the amount of malaria in the villages situated near them. Secondly, as to the effects of the increased flow in the river obtained by straightening it and bringing in more water from the bheels. If sufficient flush is obtained to uproot and wash away all the weeds with which the river is now blocked, so as to leave a clear channel full to the banks with no stagnant or slow-moving water at the edges in which mosquitoes can breed, then there is hope that one of the sources of malaria in those parts of the towns and villages which lie close to the river will be removed. It will probably have no effect on those houses which are situated at any little distance from the river and derive their mosquitoes from other sources. Possibly the new cuts made will have some effect on lowering the subsoil water in the villages situated in their vicinity, but this would be very localised, and may be counterbalanced by the possibility of the increased amount of water brought into the river and the heightening of its surface level having some effect in damming up the already-obstructed natural drainage of the subsoil water in the lower parts of the district.

The scheme therefore if successful to its utmost limit would result in some diminution of the malaria in villages along the banks of the river and in the bheels drained. There would be no general effect on the whole district involved. A constant recurring expenditure for dredging would be necessary to keep the khals from the bheels and the river itself clear and unsilted, a never-ending fight to undo what nature is trying to do, viz., to build up and heighten the general level of the country by silting.

17. What has been said of the Bhairab valley scheme would apply to any similar scheme for other silted-up areas in the district. In areas near a river with a good flow it is possible that good might be done in some instances by accelerating the silting-up process in the bheel lands around by admitting flood-water into them by cuts at times when there is much silt in the river and allowing the silt to be deposited in the bheels. It would be a slow process, but in certain instances the method has been found effectual, and it might be tried in selected tracts. It has the advantage of working in the same direction as nature, and not in opposition as in the case of draining and dredging operations.

18. The chief hope then lies in the village sanitation, but in addition to it every endeavour should be made to encourage the use of quinine and mosquito curtains, especially for children, who are the principal sufferers and the usual source of infection for others. In the present state of apathy and ignorance amongst all classes of the inhabitants, it will be extremely difficult to get much good from any of these measures, and only by a large expenditure of money and trouble will they ever be sufficiently educated to see the value of them. This education should be undertaken at once, both by teaching in all the village schools the general principles of sanitation and prophylaxis in relation to malaria, and also by providing object-lessons in various parts of the district by draining, clearing and cultivating the ground in certain villages, giving them a good water-supply, and administering quinine freely in them. The measures should be carefully carried out and would need expert supervision for many years. An immediate disappearance of all malaria is not to be expected. It is probable that for a long time there would be but a little diminution, possibly not until the present malaria-sodden generation has given place to another with constitutions unwrecked by repeated attacks in childhood.

19. In conclusion, we wish to express our thanks to Mr. B. C. Sen, Magistrate of Jessore, to the Superintendent of Police, Jessore district, and to all the officials under them for the ready assistance afforded to us in carrying out this enquiry.

Calcutta,
The 3rd January 1907.

G. E. STEWART, Capt., i.m.s.
A. H. PROCTOR, Lt., i.m.s.

Table showing the spleen-rates observed in certain villages in the Jessore district classified according to situation. Also showing the subsoil water levels of the different villages and the sources of their water-supply.

BDIVISION.	Village.	SITUATION.					JUNGLE.			SUBSOIL WATER.		Drinking water.
		Live river.	Dead river.	Bheel.		Dry land.	Thick.	Moderate.	Little.	Time of visit.	Rainy season.	
1	2	3	4	5	6	7	8	9	10	11	12	13
				Flushed.	Unflushed.					Ft.	Ft.	
... ...	Jessore, Ward I ...	...	74	...	...	...	...	...	74	11	11	
	Ditto II ...	...	92	...	...	...	92	...	...	...	...	
	Ditto III ...	...	...	...	90	...	90	...	...	...	...	
	Ditto IV ...	...	90	...	...	...	90	...	...	...	...	
	Total ...	...	83									Filtered and tank and river.
	Chowgacha	...	25	...	...	...	...	25	...	11	11	River.
	Muktadaha	...	70	...	...	...	70	...	...	6	6	Do.
	Patee Billa	...	...	57	...	...	57	...	...	...	...	Bheel.
	Ichapur	...	56	...	...	...	56	...	...	...	...	River.
	Santola	...	92	...	...	...	92	...	...	...	...	Do.
	Chiramankati	...	30	...	...	...	30	...	...	...	...	Do.
	Chatimtola	...	...	...	37	...	...	37	...	3½	3½	Bheel and tank.
	Mandalghati	...	...	88	...	...	88	...	...	4—5	4—5	Khal and wells.
	Chanchra	...	...	67	...	...	67	...	...	...	...	Tanks.
	Singhia	...	62	...	...	...	62	...	...	...	...	River.
	Basundia											
	Sadullapur											
	Kiphatnagar											
	Jaganathpur	...	73	...	...	...	73	...	...	...	...	
	Sheikhati	...	...	73	...	...	73	...	...	...	...	Wells and tank.
	Ghuli											
	Hamidpur	...	...	...	87	...	7	...	...	...	...	Wells and bheel.
	Baolia											
	Rupdia	...	64	...	...	...	...	64	...	...	...	
	Narendrapur	...	...	...	90	...	90	...	...	...	...	Tanks.
	Jirat											
	Hatbila											
	Ghoragacha											
... ...	Kaliganj	...	80	...	...	...	80	...	...	...	...	River and tank.
	Khaertala	...	...	...	81	...	...	81	...	10	1	Wells and tanks.
	Arrapur	...	...	...	85	...	85	...	...	...	...	Tanks.
	Monaharpur	...	...	...	86	...	...	86	...	...	...	Bheel.
aon	Mohespur	...	62	...	...	...	62	...	...	8	8	Tanks, wells and river.
ida	Kotchandpur	...	69	...	...	...	...	69	...	6	6	River, tanks and wells.
	Baloohar	...	...	56	...	...	56	...	...	9	7	Bheel.
	Poobohatti	...	70	...	...	...	70	...	...	...	...	River.
	Jhenida	...	89	...	...	...	89	...	...	5	4	River, tanks, and wells.
	Bhootarghati	...	...	87	...	...	87	...	...	5	4	Khal.
	Khajura	...	87	...	...	...	87	...	...	...	...	
	Koomraberi	...	...	89	...	...	89	...	...	6	4	Wells, khals and tanks.
	Kalicharanpur ...	...	...	73	...	...	73	...	...	5	4	
	Kist Kharukhala ...	...	...	72	...	...	72	...	...	...	...	Khal.
	Narayanpur	...	89	...	...	...	89	...	...	...	...	River.
	Salkopa	48	...	...	...	...	48	...	...	7	7	Do.
	Purahati	...	90	...	...	...	90	...	...	2	2	Do.
	Khalimankati ...	...	...	86	...	...	86	...	...	2	2	Bheel.
ura	Ichakhuda	...	85	...	...	...	85	...	...	6	5	River.
	Magura	38	...	...	...	...	...	38	...	12—14	2—3	River and tank.
	Attarkhuda	62	...	...	...	...	62	...	...	20	6	
	Jagla	...	...	67	...	...	67	...	...	...	...	Tanks and bheel.
	Kechnadubi	...	87	...	...	...	87	...	...	...	...	River.

Table showing the spleen-rates observed in certain villages in the Jessore district classified according to situation. Also showing the sub-soil water levels of the different villages and the sources of their water-supply—concld.

SUBDIVISION.	Village.	SITUATION.					JUNGLE.			SUBSOIL WATER.		Drinking water.
		Live river.	Dead river.	Bheel.		Dry land.	Thick.	Moderate.	Little.	Time of visit.	Rainy season.	
1	2	3	4	5	6	7	8	9	10	11	12	13
				Flushed.	Un-flushed.					Ft.	Ft.	
Magura	Arpara	...	78	...	...	...	78	...	...	...	...	River.
	Talkhari	...	...	83	...	...	83	...	...	8	2	Bheel and wells.
	Sangdaha	...	47	...	...	...	...	47	...	...	...	River.
	Singeswar	...	...	89	...	...	89	...	...	9	3	Tanks and wells.
	Satakhali	...	...	86	...	...	86	...	...	...	...	Tanks and bheel.
	Katoli	...	...	90	...	...	90	...	...	12		Tanks and wells.
	Salukha	71	...	...	...	...	71	...	...	14	7	River.
	Boyra	48	...	...	...	...	48	...	...	...	...	Do.
	Baolia	...	...	50	...	...	...	...	50	...	...	Bheel.
	Rampur	...	...	84	...	...	84	...	...	...	...	Casual water.
	Boonaghati	81	...	...	...	...	81	...	...	...	...	River.
	Nohatta	28	...	...	...	...	...	28	...	...	...	Do.
	Mubarakpur	...	...	16	...	...	...	16	...	...	...	Tanks and casual.
	Parmesharpur	31	...	...	...	...	31	...	...	...	...	River.
	Phulbari	...	...	77	...	...	77	...	...	...	...	Khal.
	Chakoolia	...	...	64	...	...	64	...	...	...	...	Do.
	Kalinagar Kaligachi	...	...	7	...	...	...	...	7	...	...	Casual.
	Dariapur Dariabheel	...	...	73	...	...	73	...	...	...	...	Bheel.
	Amalshahar	...	...	86	...	...	86	...	...	15	...	Do.
	Sripur	30	...	...	...	...	...	30	...	6	...	River.
	Goalpara	33	...	...	...	...	3	...	...	...	...	River and tank.
	Bongaon	...	...	67	...	...	67	...	...	...	...	Bheel.
	Singadanga Durgapur	...	...	61	...	...	61	...	...	...	...	Do.
	Jagdal	...	...	50	...	...	50	...	...	...	...	Do.
	Rupdia Singapur	...	...	91	...	...	91	...	...	...	...	Do.
	Dharmadaha	...	...	86	...	...	86	...	...	12	...	
	Satreejatpur	59	...	...	...	...	59	...	...	...	...	River.
	Benodpur	48	...	...	...	...	48	...	...	...	...	Do.
	Muhammadpur	...	...	60	...	...	60	...	...	...	...	Bheel and tank.
Narail	Narail	65	...	...	...	...	65	...	...	8	...	River.
	Singha	...	...	...	...	...	...	...	...	...	...	Do.
	Purulia Ambari	...	...	18	...	...	18	...	...	...	...	Do.
	Chachorea	...	...	30	...	...	...	30	...	...	...	Tanks and casual.
	Ramchandrapur	...	...	80	...	...	80	...	...	...	...	Bheel.
	Burikhali	...	...	52	...	...	...	52	...	...	...	Tanks.
	Muldair	...	...	73	...	...	...	73	...	...	...	Do.
	Nakshi	...	...	86	...	...	...	86	...	...	...	Tank.
	Rathadanga	48	...	...	...	...	48	...	...	...	...	River.
	Ragunathpur	58	...	...	...	...	58	...	...	...	...	Do.
	Sitarampur	...	...	17	...	...	...	...	17	...	...	Bheel.
	Toolarampur	24	...	...	...	...	...	24	...	...	...	Khal and tanks.

INTERIM REPORT ON THE NADIA DISTRICT.

THIS enquiry was carried out in continuation of that in the Jessore district, previously reported, and on similar lines. It included the following areas:—Kumarkhali thana in Kushtia subdivision; Gangni thana in Meherpur subdivision; and Jibannagar thana in Chuadanga, which had been reported as being particularly unhealthy, and was carried out between the 4th and 19th January 1907.

2. *Character of the country.*—In Kumarkhali thana the area visited was roughly a triangle bounded on the north by the Padma or Ganges river, on the south and west by the Gorai, and on the east by the Faridpur district. The Gorai river is reported as much silted up at its commencement for about five miles, but it is still a clear flowing river with sandy bottom, unblocked by weeds, the banks on each side rising 20—30 feet above the present level of the river. At the end of the rains the whole area is covered with water, but at the time it was visited it was dry and cultivated except a large tract to the west occupied by the Churikole bheel, in which the water remains stagnant throughout the year, and the villages, built on mounds, are always surrounded by water.

Gangni thana is situated between the Mathabhanga river on the east and the Kajla khal on the north and west. The Mathabhanga has still a good flow, but the Kajla khal has silted up at its take-off from the Mathabhanga, and is now a stagnant, weed-grown channel. This tract of land is now dry and for the most part cultivated; it is said not to be flooded as a whole after the rains, but there is a great deal of water in and around most of the villages. It is intersected by several khals, draining bheel areas, all of which are stagnant or nearly dry at this time of the year.

Jibannagar thana is intersected by the Bhairab or Cobadak river, which is here nearly stagnant, overgrown with weeds, the banks low and often marshy on both sides; the take-off from the Mathabhanga being only open at very high flood times. On both sides of the river the ground at this time of the year is mostly dry, but there are several bheel tracts, connected with the river by silted-up khals, where water remains stagnant most of the year.

3. *Prevalence of malaria.*—In Kumarkhali thana the prevalence of malaria was estimated by spleen counts of 1,326 children in 17 villages, giving a total spleen-rate of 47 per cent. In Jibannagar thana 608 children were examined in eight villages, with a total spleen-rate of 67 per cent. In Gangni thana 1,689 children were examined in 18 villages with a total spleen-rate of 80 per cent.

The spleen-rates obtained in Gangni thana were, with one or two exceptions, all extremely high, but in this thana it is probable that a large proportion of the spleen-rate is due to Leishman-Donovan infection and not to malaria. In Kumarkhali thana only three cases of advanced Leishman-Donovan infection were seen, and in Jibannagar a few cases in one village only. In Gangni thana on the other hand what appeared to be advanced cases of Leishman-Donovan infection were seen in 17 out of 18 villages examined, and in most of these villages they were pretty common. This unfortunately renders the spleen-test useless as a method of estimating malaria in this area, and for this reason the spleen-rates in the villages in Gangni thana cannot be compared with those in the other thanas, where the disease appears to be so rare as to render it negligible. Gangni thana will therefore be considered separately afterwards, and Kumarkhali and Jibannagar be taken together in the following remarks.

4. *Local conditions affecting the prevalence of malaria.* (*A*) *Village sanitation.*—The village conditions are practically the same as those mentioned in the Jessore report. The influence of the amount of jungle in a village is shown by the following table, and is very striking, even more so than in the Jessore District:—

Character of jungle.	Number of villages examined.	Average spleen-rate.
Thick	18	63
Moderate and little ...	7	37

It will be noted in the list of villages appended that all the very low spleen-rates were obtained without exception in villages with moderate or little jungle. In Bolarampur in Kumarkhali thana, which had the very small rate of 5 per cent., there was practically no jungle, and the ground between the houses was cultivated.

(*B*) *Subsoil water.*—Observations were made of the level of the subsoil water at the time of visit and the reported levels at the end of the rains. These are given in the list of villages at the end of the report. No connection is apparent between these levels and the spleen-rates obtained. Continuous observations over several years would probably be necessary to establish any connection between the rise and fall of subsoil water and malaria.

(*C*) *Situation of villages.*—Owing to the exclusion of the villages of Gangni thana, there remain hardly a large enough number of villages to draw any conclusions as to the effects of situation on malaria. Taking the two thanas of Jibannagar and Kumarkhali as a whole, it may be said that the former, intersected by the Bhairab river, is an area of dead rivers, and the latter with the Padma on one side and the Gorai on the other is an area of live rivers. The average spleen-rate in Jibannagar thana was 67 per. cent., and in Kumarkhali 47 per cent.

The following table shows the average spleen-rates obtained in villages of these two thanas situated on live and dead rivers, on bheels, on dry land which is flooded annually, and on dry land not flooded as a rule :—

Table showing effect of situation on spleen-rates.

Position.		Number of villages examined.	Average spleen-rate.
River	Live	5	54
	Dead	4	71
Bheel		6	65
Dry land	Flooded	6	46
	Not flooded	4	41

From this table it appears that villages on dead rivers are the most unhealthy, those on bheels coming next. Villages situated on dry land, whether flooded annually or not, give the lowest spleen-rates, smaller even than those on the banks of live rivers. As in the Jessore district, great variations were found in villages belonging to the same class as regards situation, and it is necessary to consider some of these cases separately.

The village of Bolarampur in Kumarkhali thana with a spleen-rate of 5 per cent. is situated in country which, at the time it was visited, was dry and cultivated, but stated to be covered with water in the rains ; drinking water is got from ring wells ; the subsoil water at the time of visit was 16 feet, and in the rains it was said to be level with the ground. The houses were in groups with little or no jungle about them, and the ground between the groups of houses was opened and cultivated. The three villages Jaintihajra, Radhanagar, and Mohesbathan, with spleen-rates respectively of 55, 55, and 37, were all situated within a few miles of Bolarampur, under similar conditions of situation, and drinking and subsoil water, but were all noted as having thick jungle. Ajoodea and Dhobrakhol, with spleen-rates of 16 and 26, were also in close proximity and under similar conditions, except that the surrounding country was stated not to be flooded annually, but only in years of high floods, such as 1906. Both these villages were noted as having very little jungle. In Jibannagar thana the villages Banka and Shahpur with spleen-rates of 26 and 98, respectively, were situated, one about one mile from the right bank, and the other about two miles from the left bank, of the silted-up Bhairab river. Their situation was on similar ground, there were no bheels or khals in their vicinity, drinking water was from the river Bhairab and wells in the case of Banka, and from tanks and wells in the case of Shahpur. The main difference apparent was the amount of jungle and excavations present, which were very bad in Shahpur, and only moderate in Banka. It is difficult to explain the extreme unhealthiness of Shahpur, which belongs to the class of villages situated on dry land, not flooded, and would have been expected to be more healthy than the village of Andolberia, situated near by, but on a dead river, and having a spleen-rate of 61 ; or than Khashipur, also close by, but on dry land, which is flooded annually in the rains, and having a spleen-rate of 47 only. No cases of Leishman-Donovan infection were seen in Shahpur.

Taking the classes in turn, the villages on live rivers show remarkable variations in spleen-rates, from 74 per cent. in Burulia to 38 in Sondah. These are two adjoining villages along the bank of the Gorai river, similar in situation, water-supply and in the amount of jungle present. The sub-soil water was deeper in Burulia than in Sondah at the time of visit, while at the end of the rains it was about equally high in both villages, so that the village in which the fall was most rapid was the most unhealthy.

In the class of villages on dead rivers, the spleen-rates were all high, but showed no great variations. They were all in the Jibannagar thana along the Bhairab river.

Of the villages on bheels, Chondoberia was the healthiest with a spleen-rate of 36, and Narayanpur, the most unhealthy, with a rate of 83. These villages lie in different thanas and are hardly comparable. Putia, however, with a spleen-rate of 81, is on the same bheel as Chondoberia, and may be compared with it. Chondoberia lies to the north of the Churikole bheel in Kumarkhali thana, it is always flooded after the rains, the houses are built on high mounds, jungle is thick round the houses, and there is much casual water about. The subsoil water at the time of visit was 6 feet ; during the rains, the subsoil and surface water meet, but at the time of visiting it the land in the village was dry. Putia lies to the west of the same bheel, but is surrounded by water or marsh all the year, the houses being built on ground in a swamp. The jungle is only moderate in amount, but there is a great deal of casual water everywhere. At present the village can only be approached in boats. The main difference, therefore, between the two villages is the amount of water in and around them after the rains ; in Chondoberia it drains off or dries up fairly soon ; in Putia never altogether. From this, it would seem probable that the health of such villages might be improved by draining the bheel. There is a project on hand at present to drain this Churikole bheel, with the object of obtaining the land for cultivation. If an accurate estimation of the amount of malaria in the surrounding villages were undertaken for several years before and after the drainage was carried out, it would form a valuable experiment as to the effect of such works in general, at no greater cost than the salaries of the observers, as the drainage scheme itself is expected to be a profitable one.

In the class of villages on dry land flooded annually, reference has already been made to the small spleen-rate obtained in Bolarampur. On the other hand, Batikamara has a very high rate as compared with the other villages in its class. This village, situated on the outskirts of the Kumarkhali municipality, is in an extremely insanitary condition. The houses are on raised mounds and between and to them run roads and paths raised on bunds without any culverts; after the rainy season the spaces between these bunds are left full of dirty weed-grown water. These and the excavations made in building the houses and raising their sites form innumerable breeding places for mosquitoes. It is probably this that renders this village more malarious than others in its class, which are fortunate in not being so advanced as to have their roads and paths raised on bunds.

In the class of villages on dry land not flooded, Shahpur is the only one with marked variation from the average, and has been noted already.

In nearly all the villages in Kumarkhali thana, fever was said to have been less than usual in 1906, and this is attributed to the unusually high flood. This belief in the beneficial effects of heavy floods appears to be universal in these districts, and is probably correct. The explanation lies in the complete washing out of the tanks and collections of casual water in the villages, in the cleansing effects on the village surroundings, and possibly the drowning out of the thick undergrowth.

5. *Mortality due to malaria.*—Histories of illness was obtained from the relatives of 195 persons who had died during the last two years in the three thanas Kumarkhali, Gangni, and Jibannagar, and whose deaths had been registered as "fever." An analysis of the cases is given in the following table with the monthly incidence:—

Analysis of 195 deaths registered as "fever" with monthly incidence.

MONTH.	Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and Diarrhœa.	Typhoid.	Born feeble.	Leishman-Donovan infection.	Other causes.	Doubtful.	Total.
January	4	6	8	4	3	4	1	...	1	3	4	38
February	1	1	1	...	1	1	1	...	1	...	...	7
March	2	2	...	1	...	3	...	...	2	...	...	10
April	1	5	1	1	1	2	1	...	...	4	...	16
May	2	1	1	...	...	...	...	...	...	...	...	4
June	1	4	...	...	1	1	...	...	...	...	...	7
July	1	5	1	...	...	...	...	...	1	6	..	14
August	1	4	...	1	1	2	...	1	...	3	...	13
September	6	2	...	1	1	...	2	...	...	2	...	14
October	5	3	...	...	3	3	1	...	3	2	2	22
November	...	1	...	1	...	...	1	...	...	1	...	4
December	8	12	4	3	3	5	1	...	4	5	1	46
Total ...	32	46	16	12	14	21	8	1	12	26	7	195
Percentage of total "Fever" death.	16·4	23·6	8·2	6·2	7·2	10·7	4·1	·5	6·2	13·3	3 6	100

The figures in themselves are too small, but they correspond very closely to those obtained in the Jessore district. The percentage of deaths due to malaria is slightly higher, —40 per cent. as compared with 34·9 per cent. in the Jessore district. Chronic malaria formed a larger proportion of "fever" deaths than acute malaria, while the opposite was the case in Jessore.

Leishman-Donovan infection was probably the cause of 12 deaths out of the 195; of these, 11 deaths occurred in Gangni thana, and only one in the other two thanas, where it appears to be a rare disease.

6. The age incidence of the different diseases is given in the following table:—

AGE.	Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and Diarrhœa.	Typhoid.	Born feeble.	Leishman-Donovan infection.	Other causes.	Doubtful.	Total.	Percentage of total "Fever" deaths.
Under 1 ...	3	1	1	1	...	1	...	1	...	...	...	8	4·1
1—5 ...	12	8	1	...	...	7	...	...	1	5	...	34	17·5
6—10 ...	4	8	1	1	...	2	...	...	6	2	...	24	12·3
11—15 ...	2	3	...	...	...	1	1	...	2	...	1	10	5·1
16—20 ...	...	7	...	2	2	1	1	...	1	...	...	14	7·2
21—30 ...	5	3	1	1	5	3	5	...	2	5	...	30	15·3
31—40 ...	3	4	2	2	2	2	...	...	...	2	1	18	9·2
41—50 ...	1	5	4	1	5	1	1	...	...	2	2	22	11·3
51—60 ...	2	7	4	3	...	1	...	...	...	2	2	21	10·8
Over 60 ...	...	...	2	1	...	2	...	...	...	8	1	14	7·2
Total ...	32	46	16	12	14	21	8	1	12	26	7	195	100

This table shows that about half of the deaths due to acute malaria occur in children under five years old, and that about half of the deaths due to acute and chronic malaria occur under ten years.

7. The death-rate directly due to malaria may appear to be very large, but it must be remembered that practically all are untreated with quinine. Unfortunately there appears to be a great prejudice among the villagers against the use of quinine, due probably to its having been found inefficient, either because too small or too few doses were used, or because its action has been prevented by constipation, which appears to be a very common condition among the people. The value of a preliminary purge might be printed on the packets of quinine sold at the post offices. The administration of quinine to children is always a difficulty owing to the unpleasant taste, and the villager, already sceptical of its value, probably seldom gives it to them, or, if he gives it once, does not do so again.

The introduction of some more palatable form of quinine for sale in the post offices might be of value if it can be obtained sufficiently cheap.

8. *Conclusions.*—It has been shown that villages on dead rivers and on bheel lands, positions in which there may be obstructed drainage, have a higher spleen-rate than those on live rivers or dry land. The obstruction of the drainage may be looked upon as a predisposing cause for the malaria in these villages. The proximate exciting cause, without which the high subsoil water and obstructed natural drainage would be comparatively harmless, lies in the insanitary conditions in the villages themselves which have already been referred to in the report on the Jessore district.

9. *Remedial measures.*—These are the same as already given in the Jessore district, but this district offers in the Churikole bheel an excellent opportunity for testing at a small cost by experiment the influence of draining bheel land on the malaria in the villages on or at the side of the bheel; it is unlikely that it will affect villages situated further away. The preliminary estimation of the malaria present should be begun at once, as it would be necessary to carry it on for a considerable period before and after draining the bheel by observations taken at all times of the year in greater detail than was possible for the present observers.

Rice cultivation in and around the villages is very general in the district; as long as this continues, it will not be possible to lessen materially the malaria in them. Only the cultivation of dry crops within a certain distance of villages should be permitted. It is believed that regulations to this effect have been in existence for two or three centuries in other countries.

10. *Gangni thana.*—The conditions found in this thana were so strikingly different from those found in the other two thanas of this district or in the Jessore district that it is necessary to consider it separately.

It is an area in which during the rains the villages are reported as not being flooded, but the country intervening is largely covered with water. At the time it was visited, about the middle of January, most of the country was dry and cultivated, with some marshy bheel tracts here and there. The drainage of the area is mainly by the Khajla and Chauteea khals. The former used to have a connection with the Matabhanga river, but this has now silted up. At the time of our visit, these bheels were stagnant, weed-grown and without current. The Chauteea khal was in many places dry, so that it was merely a chain of stagnant pools. Branches of these two khals intersect the thana, but were almost all dry in January.

Eighteen villages were examined in this thana with a total spleen-rate for the thana of 80. The rates of Kumarkhali and Jibannagar thanas in Nadia were 47 and 67, respectively, and of the Jessore district 62.

The villages, as a rule, had not a great deal of jungle in them; only one, Ghoradhope, was noted as having thick jungle. No connection is apparent between the amount of jungle present and the spleen-rates, high spleen-rates occurring even where there was little jungle.

11. On classifying the villages according to situation in the manner done with the other two thanas, the difference is striking. Unfortunately the figures are rather small for accuracy.

Situation.		Number of villages examined.	Average spleen-rate.
River ...	Live	...	...
	Dead	4	66
Bheel ...	...	3	76
Dry land ...	Flooded ...	2	95
	Not flooded ...	9	92

The above table shows a condition the reverse of that in the other two thanas of this district, the villages situated on dry land being much worse than the other classes.

12. In taking the spleen counts in this thana, the observers were struck by the large number of cases typical of the condition found in advanced Leishman-Donovan infection, great emaciation of the body and limbs, large protuberant abdomen, extremely large hard spleens, the liver often enlarged to or below the umbilicus, anæmia but not very profound, many cases showing *cancrum oris*, and many children apparently recovering with old scars of *cancrum oris*. This condition cannot be missed; it is absolutely different from the usual type of malarial cachexia. It was unfortunately impossible to ascertain definitely the presence of Leishman-Donovan bodies in these cases owing to the lack of hospital accommodation, but

there is little doubt that the condition is not malarial. Further investigation is necessary to ascertain the extent of the area in this district affected by the disease and its prevalence.

There appeared to be a greater proportion of very large spleens in the villages affected by this disease than in the villages where malaria only was present. In 22 villages in the Nadia district which were noted as having no Leishman-Donovan infection, 903 cases of enlarged spleen were examined, out of which 311, or 34 per cent. were enlarged to or below the unbilicus; while in 21 villages where Leishman-Donovan cases were seen, 1,474 cases of enlarged spleen were examined, out of which 730, or 50 per cent., were down to or below the umbilicus.

The disease is unfortunately almost impossible to distinguish in its early stages except by spleen puncture or accurate observations in hospital, so that the observers could only judge its prevalence roughly by the number of what appeared to be advanced cases of the disease present in each village.

13. In this thana histories of 66 deaths registered as "fever" were obtained with the following results:—

Analysis of 66 "fever" deaths in Gangni Thana.

	Number.	Percentage of "fever" deaths.
Malaria, acute	12	18·2
„ chronic	14	21·1
Bronchitis	6	9·1
Pneumonia	4	6·2
Phthisis	3	4·5
Dysentery and diarrhœa	6	9·1
Typhoid	3	4·5
Born feeble	1	1·5
Leishman-Donovan	11	16·6
Other causes	4	6·2
Doubtful	2	3·0
Total ...	66	100

The figures are too small, but they show that while malaria is responsible for about the same proportion of the "fever" deaths as in the three thanas of Nadia taken together, in Gangni thana there is a large increase of deaths due to Leishman-Donovan infection. In Gangni thana there were 11 deaths from Leishman-Donovan out of 66 "fever" deaths; in Jibannagar and Kumarkhali thanas there was only one out of 129 "fever" deaths. In this thana therefore there is probably a large mortality due to Leishman-Donovan infection in addition to malaria. In nearly all the villages where Leishman-Donovan cases were seen, the villagers stated that fever has been severe during the last two to six years only; in the villages in the other two thanas, the history generally was that fever had been severe for twenty to thirty years.

14. Taking the average death rate per 1,000 from "fever" for the four years 1898—1901 inclusive, in Kumarkhali it was 38·07, in Jibannagar 26·31, and in Gangni 23·83. For the four years 1902—1905, inclusive, the average rate was—Kumarkhali 40·43, Jibannagar 41·40, Gangni 45·23; that is, Gangni from being the lowest has become the highest, and has nearly doubled its death-rate for "fever."

The presence of Leishman-Donovan disease in considerable amount renders the spleen-count unreliable in estimating the prevalence of malaria. In one village, Shahbari, no cases were seen, and there was a spleen-rate of 25 only; in another, Malmari, only one case was seen, and this had a spleen-rate of 51. These were the two lowest counts obtained in this thana. From the result of the analysis of the "fever" deaths and from the death-rates per 1,000 according to the Sanitary Commissioner's reports, it is probable that malaria is as equally prevalent as in the Kumarkhali and Jibannagar thanas. The average death-rate per 1,000 from fever during the four years ending 1905 was 45·23; of this about 16·6 per cent. or 7·5 may be taken as due to Leishman-Donovan, leaving a "fever" death-rate of 37·73, slightly less than that of the Kumarkhali and Jibannagar thanas for the same period.

15. The Gangni thana on the whole may be taken as an area of "dead" rivers, as the Kajla khal, the main drainage channel, has lost its connection with the Matabhanga, and at the time this thana was visited was stagnant and the Chauteea khal was in the same condition. The question whether drainage is obstructed is more difficult; apparently at the end of the rains the country is mostly covered with water, and at the time it was seen in January it was dry except for some comparatively small marshy areas.

16. The subsoil water level as ascertained in January and from the reports of the villagers as to the water level in the wells at the end of the rains, does no appear to be so high as in Kumarkhali thana, and to be about the same as in Jibannagar thana. The method of ascertaining the subsoil water levels by observations of the height of the water in wells is of course very rough, as the levels of the situation of the wells themselves vary very much and cannot be estimated accurately by the eye.

BERHAMPORE;
The 18th February 1907.

G. E. STEWART, CAPT., I.M.S.
A. H. PROCTOR, LT., I.M.S.

Table showing the spleen rates observed in certain villages in the Nadia district classified according to situation; also showing the subsoil water levels of the different villages.

Thana.	Village.	Situation.					Jungle.			Subsoil water.		Remarks.
		Live river.	Dead river.	Bheel.	Dry land.		Thick.	Moderate.	Little.	Time of visit.	After rains.	
					Flooded.	Not flooded.						
										Ft.	Ft.	
Kumarkhali	Kumarkhali ...	54	...	...	...	...	54	..	...	12	8	
	Elangi ...	...	...	62·5	...	...	62·5	...	...	7	...	
	Burulia ...	74	...	...	...	...	74	...	...	27	...	
	Sondah ...	38	...	...	...	...	38	...	...	12	1	
	Hobaspur ...	62·5	...	...	...	...	...	62·5	...	12	1	
	Linipara ...	44	...	...	...	...	44	...	...	...	...	
	Chondoberia ...	...	...	36	...	...	36	...	...	6	...	
	Majgram ...	...	...	46	...	...	...	46	...	...	...	
	Jaintihazra ...	...	...	...	55	...	55	...	...	10	...	One case, Leishman-Donovan.
	Radhanagar ...	...	...	...	55	...	55	...	...	12	1	
	Mohesbathan ...	...	...	...	37	...	37	...	...	10	...	
	Bolarampur ...	...	...	...	5	...	...	...	5	16	...	
	Ajoodea ...	...	...	...	...	16	...	...	16	11	5	
	Dhobrakole ...	...	...	...	...	26	...	...	26	...	...	Ditto.
	Batikamara ...	...	...	...	80	...	80	...	...	12	...	Ditto.
	Putia ...	...	...	81	...	...	...	81	...	4	...	
	Churikole ...	...	...	80	...	...	80	...	...	...	...	
Jibannagar	Jibannagar ...	...	76	...	...	...	76	...	...	...	...	
	Daulatganj ...	...	77	...	...	...	77	...	...	18	6	
	Narayanpur ...	...	...	83	...	...	83	...	...	...	...	
	Banka ...	...	...	...	...	26	...	26	...	12	1	
	Andolberia ...	...	61	...	...	...	61	...	...	...	...	
	Shahpur ...	...	...	...	...	98	98	...	...	14	6	
	Kashipur ...	...	...	...	47	...	47	...	...	10	3	
	Othele ...	...	71	...	...	...	71	...	...	9	2	Some Leishman-Donovan.
angni ...	Ekori ...	...	...	...	...	97	...	97	...	12	3	Several cases Leishman-Donovan.
	Bathanpara ...	...	...	...	...	98	...	98	...	12	3	Ditto.
	Raipur ...	...	...	...	...	98	...	98	...	12	3	Ditto.
	Gangni ...	...	...	...	...	77	...	77	...	14	3	A few cases Leishman-Donovan.
	Dankhola ...	...	...	...	...	85	...	85	...	15	8	Ditto.
	Heriadaha ...	...	...	...	...	89	...	89	...	18	10	Ditto.
	Gopalnagar ...	...	...	...	98	...	...	...	98	7	...	Many cases Leishman-Donovan.
	Jaghurghopa ...	...	...	...	...	97	...	...	97	...	...	Ditto.
	Soletaka ...	...	...	...	92	...	...	...	92	8	4	Some cases Leishman-Donovan.
	Moheshnagar ...	...	...	65	...	...	...	...	65	12	5	Ditto.
	Changara ...	...	...	...	...	92	...	92	...	14	6	Ditto.
	Debipnr ...	...	...	70	...	...	...	70	...	12	3	Ditto
	Jorepukuria ...	...	...	...	...	96	...	...	96	11	6	Many cases Leishman-Donovan.
	Terain ...	...	...	92	...	...	...	2	...	8	4	Ditto.
	Hinda ...	...	91	...	...	...	...	91	...	12	7	Some cases Leishman-Donovan.
	Malmari ...	...	51	...	...	...	...	...	51	...	...	One case Leishman-Donovan.
	Ghoradope ...	...	96	...	...	...	96	...	...	11	3	Some cases Leishman-Donovan.
	Shahbari ...	...	25	...	...	...	...	25	...	10	4	No cases Leishman-Donovan.

INTERIM REPORT ON THE MURSHIDABAD DISTRICT.

THE following enquiry on the prevalence and distribution of malaria in the Murshidabad district was carried out in continuation of, and on similar lines to, the enquiry already reported in the Jessore and Nadia districts. The district was visited between the 25th January and the 23rd February 1907.

The area visited was a strip of land on each side of the Bhagirathi river, from Gora Bazar on the south to the retired line of the Bhagirathi embankment on the north; also that part of the Bhagwangola thana lying outside of the retired line of the Bhagirathi embankment and the Lallgola and Hariharpara thanas.

2. *Physical character of the country.*—The main drainage channel in the area visited is the Bhagirathi river, which, though still a clear flowing stream with a sandy bottom free from weeds, has no great depth of water and in many places is almost blocked by sand banks. It is stated to have degenerated greatly in recent times. To the east of the Bhagirathi and running roughly parallel to it at a distance varying from two to six miles is the Gobra nala. This was formerly a spill channel from the Bhagirathi river, but has now been cut across by the retired line of the embankment in the Bhagwangola thana, and receives only local drainage water south of that embankment. It is stated to be silted up in its lower reaches and at this time of the year has practically no current. It still has a good deal of water, however, in that part of it which lies to the east of the Sadar subdivision; further north, in the Lallbagh subdivision, it is much narrower and becomes merely a marsh in many places. The drainage of the area lying between the Bhagirathi and the Gobra nala is mainly from the Bhagirathi towards the Gobra nala. This area contains many bheel tracts, especially round Berhampore and in the Shahanagar thana, but the greater part of the country is dry and cultivated at this time of the year. It was reported as being very malarious.

Hariharpara thana consists of flat cultivated land traversed by the Bhairab river and numerous khals, which at this time of the year are almost stagnant channels, similar to the Gobra nala, or merely marshy hollows. In the rains the country in this thana is mostly under water, but it is stated to dry up very rapidly and completely after their cessation, showing that the drainage channels of the area as a whole are sufficient for carrying off the surplus water, though for want of water entering higher up there is no flow in them in the dry season.

In the parts of the Bhagwangola and Lallgola thanas lying outside the retired line of the embankment, the country is completely flooded from the Bhagirathi river during the rains, and many of the villages have to be evacuated by their inhabitants, who live on the top of the embankment until the floods go down. The country is now dry and cultivated, and the drainage channels are mostly dry or stagnant. Inside the embankment in the Lallgola thana the country is partly covered with rain water during the rains, but is not flooded by river water as a rule.

On the western side of the river there is a strip of flat alluvial country extending to about eight miles from the river, in which there are some large bheel tracts, and where the villages are flooded with rain water during the wet season. Further west it becomes undulating non-alluvial country with villages which are not flooded in the rains and are said to be much less malarious.

3. *Prevalence of malaria.*—This was ascertained by taking spleen-rates of children under 12 years. Altogether 4,744 children were examined in 70 villages, and 1,952 were found to have enlarged spleens, giving a spleen-rate for the district of 41·1. This is a lower rate than that in the Jessore and Nadia districts. The different areas visited in this district vary considerably in their average spleen-rates.

The most unhealthy part was a tract extending southwards from the retired line of the Bhagirathi embankment between the Bhagirathi river and the Gobra nala; with this may be included the Hariharpara thana lying to the east of the Gobra nala, where the physical conditions and the prevalence of malaria are similar. In these areas 28 spleen-rates were taken with an average of 62·6, approximately equal to the average spleen-rate of the Jessore district, and the thanas examined in the Nadia district which were free from Leishman-Donovan infection. The most healthy part of this tract appears to be along the bank of the Bhagirathi river, where the villages gave an average spleen-rate of only 37·2. Further away from this river, the villages lying on dry land gave a rate of 67·2, those on dead rivers and khals 66, and those on bheels 80. In this area the average difference between the subsoil water level at the time of visit and at the end of the rains, obtained in wells in 21 villages, was 9·8 feet.

In the Bhagwangola and Lallgola thanas 26 spleen-rates were taken with an average of 32·7; of these, 13 villages were outside the retired line of the Bhagirathi embankment, unprotected from the annual flood from that river, and gave an average spleen-rate of 29·9; and 13 villages were inside the embankment, and not flooded annually from the river. These gave an average spleen-rate of 35·6. In these two thanas the average fall in the subsoil water from the end of the rains to the time of visit, obtained in 20 villages, was 12·9 feet, showing a greater fall than in the former area.

Eleven villages were examined in the tract lying west of the Bhagirathi river, opposite to Berhampore and Murshidabad, with an average spleen-rate of 33·6. This average, however, probably does not represent the true rate for the area, as it was reduced by one village, Gowkaran, which lies beyond the alluvial tract of country and has a spleen-rate of 2 only, and by 3 villages on the Telkar bheel which had very low rates. These will be referred to subsequently. The average mortality from fever for the Assanpur thana for the years 1901—1905 was 48·6 per 1,000, nearly equal to the worst parts of the area on the east side of the river, which has an average spleen-rate of 62·6.

4. *Mortality due to malaria.*—This was estimated by enquiries into the illnesses of 242 persons who had died of "fever" in the area visited, with the following results:—

Analysis of 242 "Fever" deaths with monthly incidence.

MONTH.	Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and diarrhœa.	Typhoid.	Born feeble.	Other causes.	Leishman-Donovan.	Doubtful.	Total.
January	4	7	7	3	1	10	1	2	8	1	2	46
February	3	...	1	2	1	2	...	...	3	...	3	15
March	2	...	3	...	2	2	...	...	2	...	1	12
April	1	4	2	...	...	...	...	...	...	...	1	8
May	1	1	...	...	...	...	...	...	1	...	1	4
June	1	2	2	1	...	2	...	...	...	1	2	11
July	5	4	...	...	2	...	3	1	1	2	1	19
August	10	5	2	1	1	3	...	...	...	...	5	27
September	5	3	...	1	2	5	1	1	5	...	...	23
October	6	3	3	...	...	3	1	1	3	...	4	24
November	10	3	2	1	...	5	...	2	4	...	...	27
December	4	1	4	1	4	5	...	...	6	...	1	26
Total ...	52	33	26	10	13	37	6	7	33	4	21	242
Percentage "Fever" deaths ...	21·6	13·6	10·7	4·1	5·4	15·3	2·5	2·9	13·6	1·6	8·7	100

The results approximate very closely to those obtained in the Jessore and Nadia districts. Malaria, acute and chronic taken together, forms roughly one-third of all the deaths registered as "fever." Chronic malaria forms about the same proportion of the malaria deaths as in the Jessore district, but less than in the Nadia district. Dysentery and diarrhœa are responsible for 15·3 per cent. of the "fever" deaths, as against 11·3 per cent. and 10·7 per cent. in Jessore and Nadia respectively. Leishman-Donovan infection is credited with 1·6 per cent. of the "fever" deaths. This disease is extremely difficult to separate from chronic malaria by the method of questioning the relatives of deceased persons, but it appears to be present only in small amount in this district.

The following table gives an analysis of these 242 cases according to age:—

AGE.	Malaria, acute.	Malaria, chronic.	Bronchitis.	Pneumonia.	Phthisis.	Dysentery and diarrhœa.	Typhoid.	Born feeble.	Other causes.	Leishman-Donovan.	Doubtful.	Total.	Percent age of "Fever" deaths.
Under 1	7	...	3		...	3	...	7	5	...	...	27	11·2
1—5	15	8	4	...	...	11	1	...	1	...	4	44	18·2
6—10	7	8	...	1	...	2	...	...	2	3	3	26	10·7
11—15	2	6	...	...	...	...	1	...	4	...	2	15	6·2
16—20	1	...	...	...	3	...	1	...	3	...	2	10	4·1
21—30	6	5	1	1	3	1	...	...	4	1	1	23	9·5
31—40	6	4	2	1	6	4	3	...	4	...	3	33	13·6
41—50	4	...	3	1	1	4	...	...	1	...	2	16	6·6
51—60	3	1	8	3	...	7	...	...	1	...	4	27	11·2
Over 60	1	1	5	1	...	5	...	...	8	...	...	21	8·7
Total ...	52	33	26	10	13	37	6	7	33	4	21	242	100

This table shows that nearly half of the deaths due to acute malaria occur under 5 years of age, and that about half of all deaths due to malaria are under 10. Roughly 40 per cent. of all deaths registered as "fever" occur in children under 10 years of age.

5. *Influence of situation on malaria.*—Classifying all the villages examined according to their situation, in the manner done in the former reports, gives the following result :—

Situation.		Number of villages examined.	Average spleen-rate.
Live river	... ...	11	38 6
Dead ,,	... ...	11	51·6
Bheel	... ...	7	49
Dry land	Flooded annually ...	20	39
	Not flooded annually ..	15	57

With the exception of the villages on bheels this probably represents a fair estimate of the relative healthiness of the different situations in this district. The villages on bheels consisted of four villages in the Sujaganj thana with an average spleen-rate of 80, and three villages on the Telkar bheel, west of the Bhagirathi river, with spleen-rates of 6, 6 and 11. These last three present an extremely difficult problem. They were all on the margin of Telkar bheel, to the west of the Bhagirathi river; there was a great deal of casual water about each village; they were all flooded by bheel water in the rains, and jungle was moderate in amount in all. Owing to the absence of wells no subsoil water levels could be noted. Anopheles mosquitoes were found to be fairly numerous in these villages, mostly anopheles *fuliginosus*. From their appearance they would be expected to be very malarious, but they had a very low spleen-rate, lower than the villages Raninagar and Seeamara lying between them and the river on drier ground, and still lower than Radhaghat or Gopijan actually on the bank of the river about 4 miles away. These three villages form a strong contrast to all the other villages situated on bheels in this district and in the Nadia and Jessore districts. The average spleen-rate of 80 found in the four villages on bheels examined in the Sujaganj thana probably represents the usual prevalence of malaria in the bheel villages at any rate on the east side of the Bhagirathi river more accurately than the average of 49 for the whole class

Taking the remaining classes in turn, the villages situated on live rivers give the next lowest average, but their spleen-rates vary from 10 to 71. All these villages were situated on the banks of the Bhagirathi river.

Villages on dead rivers had a fairly high average, but not so high as in the Jessore and Nadia districts. Of these two villages, Balee and Topkhana on the Gobra nala gave high rates of 79 and 83; four villages in Lallgola thana all gave moderately low rates; while five villages in Hariharpara gave rates varying from 15 to 78. Three of these form an interesting series. Shankarpur is situated on the Bhairab river, Dharmpur is ¾ mile south of Shankarpur, and Hariharpara 4 miles south of Dharmpur, all on the same river. The Bhairab river at the time it was visited was an almost stagnant channel. At Shankarpur and Dharmpur there was a good deal of water in it, but at Hariharpara it was shallow. The banks on each side of the river on which the villages are built are high, from 10—20 feet above the present water-level. Shankarpur, the most northerly village, had a spleen-rate of 15, Dharmpur 38, and Hariharpara 77. Drinking water in all cases was obtained from the river and from wells. In Shankarpur there was not much jungle, and there was a good deal of cultivation in some parts of the village between the houses. In Dharmpur jungle was moderate in amount. In Hariharpara it was moderate in the centre of the village and thick round the outskirts.

Spleen rates of villages on dry land which is flooded annually vary from 94 to 6. The highest rate was got in Benidaspur, a village of the Doulat Bazar thana, lying 1 mile east of the Gobra nala. The lowest rates were obtained in the Bhagwangola thana, where the villages are flooded annually by the Bhagirathi river. In nearly all the villages seen in this thana the houses are built on raised mounds, and there is not much jungle in the villages. The country itself, though flooded deeply in the rainy season, was dry at the time it was visited. In the Lalgola thana three villages of this class were outside the embankment and were flooded by the Bhagirathi river, and four were inside and flooded only by rain water: the latter gave the lower average spleen-rate.

In the class of villages on dry land not flooded as a rule in the rains, the village of Gowkaran has been excluded, as it lies in a different type of country outside the alluvial delta tract, and cannot be compared fairly with the other villages. Spleen-rates in the remaining villages varied from 10 to 81. In the Sujaganj thana the three villages Hathinagar, Rajnagar and Oosta form an interesting comparison. Hathinagar lies about 4 miles east of Berhampore in the centre of the tract of country between the Bhagirathi river and the Gobra nala. It is a very jungly village, with many tanks and pits full of dirty weedy water and the usual excavations round the houses. The surrounding country was dry and cultivated at the time it was seen. The spleen-rate was 80. Rajnagar lies about ¾ mile east of Hathinagar on a flat, cultivated plain; it was built by immigrants from the Nadia district about 12 years ago, and is entirely free from any jungle. There are no tanks in the village, but many excavations near the houses which, owing to the absence of trees and vegetation round the houses, are freely exposed to sunlight. The spleen-rate is 11. Oosta lies 1 mile from Rajnagar on the other side from Hathinagar with similar situation and surroundings; it has thick jungle and much casual water and many dirty tanks in the village, and has a spleen-rate of 81.

Rajnagar is therefore a healthy village lying between two very unhealthy ones with similar situations and surroundings, but with no jungle and dirty tanks in the one case, and much jungle and many dirty tanks in the other two, and affords an excellent object-lesson of the good effect of the free access of sun and light and absence of vegetation round the houses.

Taking the class of villages flooded annually as a whole it has a lower average spleen-rate than those not flooded annually, a result the opposite of that obtained in the Nadia district. The explanation is probably that in this district the majority of the villages in the flooded class are annually flooded by the overflow from the Bhagirathi river, which washes out thoroughly the village and its surroundings and sinks rapidly with the fall of the river, and also that a large proportion of these villages in the Bhagwangola thana especially are very free from jungle. In the Nadia district the villages flooded annually are mostly flooded from the local rainfall and rise of neighbouring bheels, and do not get such a thorough flush as would be got from the overflow of a river, while a large proportion of them have thick jungle.

6. *Influence of village sanitation.*—Classifying the villages according to the amount of jungle in them gives the following results:—

Character of jungle.		Number of villages examined.	Average spleen-rate.
Thick	...	17	71·8
Moderate	...	28	44·7
Little	...	19	26·3

As in the Nadia and Jessore districts this shows a decided advantage in the villages with the lesser amount of jungle. At the same time there are large differences in the individual spleen-rates of each class, especially among those villages with little or moderate jungle. The villages with thick jungle almost all have high rates, and none have very small rates. In the village of Choa in the Hariharpara thana, clearing of jungle was commenced before the onset of last wet season and is being carried on; unfortunately no previous estimate of the amount of malaria present was made, and at any rate it is too soon to expect any definite results. The inhabitants of the village state that there was less fever than usual this year, but this evidence is unreliable, and even if correct might be merely due to a more favourable year. Cultivation of the ground between the houses is also being started in this village with some little success, but the ground being held often by many shareholders makes it difficult to be carried out, as they cannot agree among themselves and are very apathetic and conservative. In time, however, there is every hope that it will be carried out on a more extensive scale, and that the upgrowth of the jungle after cutting will be prevented altogether. The operations in this village are under the supervision of Mr. Perrin, manager of the local silk factory, who is a strong believer in the advantages to be gained and is very hopeful of their future success.

7. *Influence of sub-soil water.*—No connection is apparent between the spleen-rates of villages and the height of the water in wells either at the time of visit, or at the end of the rains, as ascertained from the villagers. Some of the lowest rates were obtained in villages which are flooded during the rains. Possibly, however, the difference between the height of the water in the wells at the time of visit and at the end of the rains may afford some evidence as to the rapidity with which the subsoil water sinks, and in the following table spleen-rates of 43 villages in which the height of the well water level was taken are compared:—

Differences between well water level at the time of visit and after rains.		Number of villages examined.	Average spleen-rate.
From 4 feet — 9 feet	...	19	59·5
„ 10 „ — 15 „	...	18	47·7
„ 15 „ — 25 „	...	6	21

It appears from this that the average spleen-rate is least where the difference of well water level is most, that is, where the sinking of the subsoil water is probably quickest. At the same time there is in each of the above classes a large range in individual spleen-rates. In the class of villages where the fall was between 4 and 9 feet the spleen-rates vary from 11 to 87; between 10 and 15 feet from 6 to 94; and between 16 and 25 feet from 11 to 38. These large variations, however, are to be expected when classifying villages according to their situation, the amount of jungle in them and the subsoil water levels, as it is probable that the local prevalence of malaria is influenced by all three, and it is only by considering the averages of a large number of villages that any conclusions as to the influence of any one of these conditions can be drawn.

8. *Conclusions.*—Malaria appears to be prevalent, and there is a large mortality directly due to malaria over the whole area visited, but particularly in the area lying south of the retired line of the embankment between the Bhagirathi river and the Gobra nala, and in the Hariharpara thana. The area lying north of the retired line of the embankment appears to be more healthy. Average spleen-rates have been shown to be highest in villages with the most jungle, and also in villages and areas where the sinking of the subsoil water since the rains has been least. It is probable that it is to the combination of these two factors that the large amount of malaria is due, and not to either of them by itself.

9. *Remedial measures.*—Beyond what has been said for the Jessore and Nadia districts, little need be said of general anti-malarial measures to be undertaken; these comprise in short the clearing and improving of village sites and the filling up of tanks and pits in the villages, and also any measures which may tend to lower the subsoil water level and expedite its fall after the rains.

Of particular schemes which have been proposed for this area, the most important is that for the better drainage of the large bheels and tanks lying to the east of the Berhampore Municipality by deepening the already existing drains leading to the Gobra nala. The scheme provides for the lowering of the present level of the bheels by a few feet and not for their complete drainage. The value of this will depend on the nature of the ground which is left at the edges of the bheels: if the marshy areas remain much the same size as at present, there will be probably little effect so far as the local prevalence of malaria is due to the bheel itself. Possibly, however, by lowering the level of the bheels the subsoil water for some distance round may be also lowered, and so do good by drying or accelerating the drying up of the neighbouring ponds and marshes. The scheme also provides for the lowering of the water level in the Gobra nala by opening up its lower reaches, so as to obtain a better fall in the drains leading to it from the Berhampore bheels. The influence of this on malaria in the villages on the banks depends on the amount of marshy and stagnant water which will be left in the nala as compared with the present amount, and also on the effect this lowering will have on the subsoil water in the immediate neighbourhood of the nala. At present, although there is little current in the nala, it is full of water for a great part of its course, with little weed and fairly clear edges.

In the Hariharpara thana, it has been proposed to open up the Bingdaha khal and deepen its channel leading into the Bhairab river, and also to deepen various channels leading from neighbouring bheels into the khal. This scheme appears to be a useful one and likely to improve the health of villages near these bheels, provided that the water is not artificially kept in the bheels until late in the autumn for rice cultivation.

It has also been proposed to drain the Telkar bheel lying opposite to Berhampore on the east side of the Bhagirathi river. Both by common repute and by the spleen-rates found, the villages near this bheel are particularly healthy, so much so that it is questionable whether any attempt to alter the present condition would be wise.

10. During 1906 anti-malarial operations were carried on in Berhampore, directed towards the improving of the surface drainage, the cutting of jungle, and the kerosening of surface collections of water. This Municipality would require an enormous expenditure for such measures to be thoroughly carried out. They could be made complete only by draining or filling up the large tanks or bheels, which extend in a continuous line along the eastern side of the municipality, and are a great source of mosquitoes. Until this is done, other less ambitious measures, though they probably do some good, are unlikely to show definite result. In any case no conclusions can be drawn from the results of only one season's work.

BERHAMPORE,
The 28th February 1907.

G. E. STEWART, CAPT., I.M.S.
A. H. PROCTOR, LT., I.M.S.

Statement of villages in the Murshidabad district classified according to position, etc., and showing spleen-rates and sub-soil water levels.

Thana.	Village.	No.	Situation.			Dry land.		Jungle.			Subsoil water.			Remarks.
			Live river.	Dead river.	Bheel.	Flooded.	Not flooded.	Thick.	Moderate.	Little.	Time of visit.	End of rains.	Amount of fall.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
											Ft.	Ft.	Ft.	
Sujaganj ...	Berhampore ...	...	10	...	...	...	...	...	...	10	...	...	...	Spleen-rate from centre town near river.
	Cossim Bazar ...	...	...	...	...	...	56	...	56	...	18	3	15	
	Gora Bazar ...	...	38	...	...	...	...	...	...	38	19	1	18	
	Hathinagar ...	...	...	...	...	...	80	80	...	...	8	3	5	1 case Leishman-Donovan.
	Rajnagar ...	...	...	...	...	...	11	...	...	11	7	1	6	
	Oosta ...	...	...	...	...	...	81	81	...	...	11	5	6	2 cases Leishman-Donovan
	Gowkonda ...	...	...	...	87	...	...	...	87	...	12	6	6	
	Tarikpur ...	...	...	...	74	...	...	...	74	...	13	5	8	
	Batpara ...	...	...	...	72	...	...	72	...	...	...	...	...	
	Chunakali ...	...	...	...	87	...	...	87	...	...	14	5	9	
Daulat Bazar...	Benidaspur ...	...	...	...	...	94	...	94	...	...	14	...	14	
Shahanagar ...	Ballee ...	...	...	79	...	...	...	79	...	...	12	4	8	
	Murshidabad ...	...	58	...	...	...	...	...	...	58	...	...	...	Spleen-rate from centre town.
	Rathanpur ...	...	...	...	...	...	27	...	27	...	20	3	17	
	Khatra ...	...	...	...	...	...	79	...	79	...	...	...	...	
	Bownsagar ...	...	...	...	...	...	66	...	66	...	13	3	10	
	Kadam Sarif ...	...												
	Topkhana ...	...	...	83	...	...	...	83	...	...	12	3	9	
	Nuthangram ...	...	24	...	...	...	...	...	...	24	15	1	14	
Manoolla Bazar	Debipur ...	...	56	...	...	...	...	56	...	...	...	...	...	
	Amaipara	...	...	...	...	...	81	...	81	...	18	8	10	
	Bahadurpur ...	...	...	...	...	...	77	77	...	...	22	9	13	
	Belipookur ...	...	...	...	...	...	67	...	67	...	...	...	...	
Hariharpara ...	Hariharpara ...	...	...	77	...	...	...	77	...	...	10	4	6	
	Choa ...	...	...	70	...	...	...	70	...	...	12	2	10	
	Dharmpur ...	...	...	38	...	...	...	...	38	...	10	1	9	
	Shankarpur ...	...	...	15	...	...	...	...	...	15	12	3	9	
	Ghazneepur ...	...	...	...	...	88	...	...	88	...	14	4	10	
	Baripara ...	...	...	78	...	...	...	...	78	...	10	6	4	
Bhagwangola	Gobra ...	...	...	...	...	23	...	...	...	23	12	...	12	
	Barharea ...	...	...	...	...	6	...	...	...	6	...	...	...	
	Arizpur ...	...	...	...	...	17	...	...	...	17	...	...	...	1 doubtful case Leishman Donovan.
	Moheshnarayanganj.	...	...	...	...	6	...	...	...	6	10	...	10	
	Sheikpara ...	...	...	...	...	45	...	...	...	45	9	...	9	Some cases Leishman Donovan.

Village.	No.	SITUATION.					JUNGLE.			SUBSOIL WATER.			REMARKS.
		Live river.	Dead river.	Bheel.	DRY LAND.		Thick.	Moderate.	Little.	Time of visit.	End of rains.	Amount of fall.	
					Flooded.	Not flooded.							
2	3	4	5	6	7	8	9	10	11	12	13	14	15
										Ft.	Ft.	Ft.	
Kalipookur ...	...	...	...	...	77	...	...	...	77	...	...	...	Some cases Leishman-Donovan.
Rampur ...	...	13	...	...	...	...	...	13	...	25	...	25	
Mohatpur ...	...	...	...	...	54	...	54	...	...	...	...	...	1 doubtful case Leishman-Donovan.
Sundarpur ...	...	...	...	...	14	...	...	...	14	24	...	24	
Bussantapur ...	...	11	...	...	...	...	...	...	11	24	...	24	
Lallgola ...	...	...	35	...	...	...	...	35	...	...	...	...	
Pathanpara ...	...	...	...	...	...	10	...	10	...	20	8	12	Ditto ditto.
Chashapara ...	...	...	...	...	...	38	...	38	...	12	6	6	
Gamtola ...	...	...	...	...	...	41	...	41	...	6	1	5	
Naldari ...	...	...	17	...	...	...	...	...	17	...	...	...	
Shahabad ...	...	...	...	...	13	...	...	...	13	10	...	10	
Shikarpur and Paharpur.	...	...	37	...	...	...	37	...	...	10	5	5	
Malatipur ...	...	...	...	...	13	...	...	...	13	13	...	13	
Kalmaygha and Tegorca.	...	...	...	...	22	...	...	22	...	15	...	15	
Balarampur and Manichak.	...	...	...	...	58	...	...	58	...	15	...	15	1 case of Leishman-Donovan.
Hosainabad and Ramchandrapur.	...	...	39	...	...	...	...	39	...	14	5	9	
Durgapur ...	...	...	...	...	...	80	80	...	...	12	3	9	Ditto ditto.
Ganespur ...	...	...	...	...	...	60	...	60	...	12	1	11	
Dewan Serai ...	...	...	...	...	40	...	40	...	...	12	...	12	Outside the Bhagirathi embankment.
Marjadpur ...	...	...	...	...	57	...	...	57	...	12	...	12	
Lotatola ...	...	...	...	...	25	...	...	25	...	20	...	20	
Radhaghat ...	...	42	...	...	...	...	...	42	...	...	...	...	
Gopijan ...	...	61	...	...	...	...	...	...	61	12	7	5	
Raninagar ...	...	...	...	...	18	...	...	18	...	...	...	...	
Seeamara ...	...	...	...	...	30	...	...	30	...	...	...	...	
Oodeychandpur ...	...	...	...	6	...	...	...	6	...	...	...	...	
Parbutpur ...	...	...	...	6	...	...	...	6	...	...	...	...	
Lukhee Narayanpur.	...	...	...	11	...	...	...	11	...	...	...	...	
Elahiganj ...	...	41	...	...	...	...	...	...	41	...	...	...	
Dahapur ...	...	71	...	...	...	...	71	...	...	...	...	...	2 cases Leishman-Donovan.
Cheitanpur ...	...	...	...	...	82	...	82	...	...	...	...	...	
Gowkaran ...	...	...	...	...	...	2	...	...	2	...	...	...	Lies beyond the alluvial tract.

APPENDIX II (*vide* paragraph 40).

No. 2524, dated Calcutta, the 5th July 1906.

From—The Executive Engineer, Northern Drainage and Embankment Division,
To—The Superintending Engineer, South-Western Circle.

With reference to your No. 2253, dated the 18th April last, calling for a note on the defective or obstructed drainage in the districts under the Presidency Division, I have the honour to forward herewith a note on the drainage of that portion of the Presidency Division which lies within this Division and which is located in the 24-Parganas district, with an Index map, showing (*i*) the areas which are already efficiently drained, (*ii*) the areas being drained at present, and (*iii*) those areas which are indifferently drained.

Note on the Drainage of that portion of the Presidency Division which lies within the Northern Drainage and Embankment Division.

With the exception of one or two small areas, the drainage of that portion of the Presidency Division, which lies within the Northern Drainage and Embankment Division, was reported on in detail by Mr. Maconchy, Executive Engineer, Northern Drainage and Embankment Division, and late Superintending Engineer, South-Western Circle, in his No. 405, dated the 14th February 1901, after the severe flooding of 1900. This report will be found on pages 2 to 23 of the printed report of the Magra Hât Drainage Scheme. The country reported on was divided into 56 basins, totalling 717¼ square miles, and the defect in the drainage of each basin pointed out and the works necessary for their efficient drainage enumerated.

It was shown that, allowing 5 square feet per square mile as the approximate sluice ventage required for efficiently draining the area reported on, the existing ventage was only 1,873 square feet against 3,586 square feet required.

2. The outcome of this report was the inclusion of several of the larger basins into one large drainage scheme called the Magra Hât Scheme, having a main outfall sluice of 30 vents at Diamond Harbour, draining 219 square miles of country, and two smaller sluices on the right bank of the Peali river at Utterbhag (5 vents) and Dhosa (6 vents) draining 25 and 50 square miles, respectively. This scheme is now being carried out, and will properly drain the basins numbered 3 (24 square miles), 16, 17, 18, 32, 33, 36, 37, 38, 39, 40 and 41 in statement II of the report.

The two smaller sluices will be ready for draining during the current year, and it is hoped that the main sluice at Diamond Harbour will be completed for draining next year.

3. In addition to the above scheme, a sluice with 80 square feet ventage area is nearing completion in the 108th mile of the Sundarban embankment at Dhutkhali, and will drain 8 square miles.

A small sluice of 6½ square feet ventage is also being built at Foolbagicha in the 131st mile, draining one square mile of the Khari basin.

A scheme for draining the Arapanch basin of 30 square miles is under preparation, and work has been started in excavating the outer channel of the existing sluice.

On the east bank of the Peali river a new embankment has been made with two new one-vented sluices at Srikristopore and Tangraberia, and an application has lately been received for another sluice near Tangraberia for draining 2½ square miles of very low swamp in the Goredoho basin: estimates for this are now under preparation.

With the exception of the Magra Hât Drainage Scheme, all the schemes referred to are being carried out under the Embankment Act.

4. The accompanying index map shows in red wash the areas which were provided with sufficient drainage sluices when Mr. Maconchy wrote his report. The areas which have been drained since that report was written or are now being drained are shown in yellow wash, and those which still require further sluices are shown in blue wash. The amalgamation of several large basins under the Magra Hât Drainage Scheme renders a revision of the basins necessary, and a new statement has been prepared giving the areas of the revised basins and showing the progress of drainage and the requirements in each.

5. A reference to the Index map will show that to the west of the Calcutta-Diamond Harbour road, the basins which require more sluice ventage are basins Nos. 1, 4, 5, 7, 11, 12 and 14, totalling 112 square miles, requiring an additional ventage of about 520 square feet; these basins are in urgent need of proper drainage facilities; at present drainage is effected through open khals into the Hooghly, and these are very badly silted up, and there are large inland swamps, in which stagnant water remains till the beginning of the hot weather, when

it evaporates. Instead of draining each basin separately, it might be possible to combine several basins together into one having one or perhaps two outfall sluices and a proper system of inland channels. The basins round Falta might be combined in this way and a scheme carried out under the Sanitary Drainage Act. None of these basins have been examined in detail, and no levels have been taken, but they will be carefully explored during the current rains; some of the water crosses the Diamond Harbour road and finds an outlet into the Diamond Harbour creek through the Bindal sluice, but this area has not been included in the Magra Hât Drainage Scheme; it cannot now be included as the foundations of the Diamond Harbour sluice have been partially got in, and no alteration can now be made in the size of the sluice; the natural outfall of the basins is towards the west into the Hooghly.

6. To the east and south of the Diamond Harbour road and to the west of the Peali river matters will be much better when the present schemes being carried out are completed. The only basins not properly drained will be Nos. 17, 22, 26, 28, 42 and 3, totalling 98 square miles and requiring 409 s. ft. of additional ventage: of these basins Nos. 17, 26, 28, and 3 are in urgent need of extra sluices.

No. 17 (*Harah*) is an inland basin with no means of drainage; a sluice close to the existing one-vented sluice at Harah is badly required, but the zamindars do not appear inclined to come forward and pay the amount necessary for the scheme; practically no crops have been grown in this basin for some years.

Basins Nos. 26 and 28, Khari and Mohamaya, might be combined; the total area is 36 square miles, and a sluice ventage of 180 s. ft. is required against 81 s. ft. existing; this basin is badly flooded by overflow from other basins, especially from the Joynagore swamps now being drained by the Magra Hât Scheme; the sluice is situated about 4 miles up the outfall khall which is badly silted. A main outfall sluice is required at the mouth and the khal silt cleared.

Basin No. 3 (*Kaurapukur*).—The original area of this basin was 52 square miles; 24 square miles have now been included in the Magra Hât Scheme, leaving 28 square miles undrained. There is difficulty in draining this basin; the natural outfall is into Tolly's Nala near Russa *viâ* the Kaurapukur Khal. This khal is badly silted by the tides entering from Tolly's Nala: the proposal for building a sluice on the bank of Tolly's Nala and closing the khal was discussed, but abandoned as too risky, as it was thought that if the khal was closed it might cause extensive silting in Tolly's Nala itself. Some good might be done by constructing sluices on either bank of the Kaurapukur khal in the side khals, the main khal being left open, but this would need periodical silt clearance of the main khal. If the Tolly's Nala canalization scheme is taken up, the area might be drained into it, if the levels allow of this being done.

Basin No. 22, Jhinkra, 8 square miles.—The drainage of this basin does not seem urgent; it was formerly included in the Tangrabichi basin. The Dhutkhali sluice now under construction has 80 square feet ventage for 8 square miles, or about twice as much as is required; this sluice will relieve the Satpukur and Tangrabichi sluices which should then be able to discharge the drainage of the Jhinkra basin. It is doubtful whether any permanent relief would be obtained by constructing a sluice on the bank of the Serampore khal, as this has a long outfall to the Hooghly and is fast silting up.

7. To sum up: the total area has now been revised and included into 50 basins aggregating 757¼ square miles. The increase in the area is due to revision of the areas under the Magra Hât Drainage Scheme, and to small areas being reclaimed: of the total area, 205¾ square miles were properly drained in 1900, 333 square miles have been drained since that year or are being drained, and 28½ square miles remain to be drained.

The total ventage in 1900 was 1,873 s. ft. This is now shown as reduced to 1,385 s. ft. as some of the old sluices will discharge into the channels feeding the new sluices now under construction, and two sluices will be converted into bridges; this ventage will be increased to 3,331½ s. ft. when the schemes under construction are completed, giving a ventage area of 620s. ft. per square mile for 538¾ square miles. The remaining 218½ square miles still require 971 s. ft. of ventage more to efficiently drain them.

8. In the south of the area near Satpukur the country is at present provided with sufficient sluice ventage, but the efficiency of the sluices, especially of the Satpukur sluice, is being gradually diminished owing to the silting up of the outfalls and creeks. The Subdivisional Officer, Dum-Dum, Babu Prosunna Kumar Bose, who is an old experienced man in drainage schemes in this part of the Division, reports that the deterioration of these channels is due to the reclamation of the Sundarbans; areas are being reclaimed and the tidal spill reduced, diminishing the scour in the creeks and causing rapid silting

9. There is one other case which requires early attention. Between Garia and Soorjeepore there is an old river bed known as the Moraganga Channel or Ganga Nadi; the channel is of practically no use for drainage purposes, and consists of large pools of stagnant water which do not entirely dry up till the very end of the hot weather. Many of the pools have been formed by excavation for raising the land on either bank, and others have been formed by cross-bunding the nala. The channel passes through the Rajapur and Baruipur Municipalities, and is used for depositing corpses and rubbish. The health of these Municipalities and villages on the banks of the nala has been getting worse year by year, and the Chairman of the Baruipur Municipality has lately forwarded a petition to the Collector addressed to the Lieutenant-Governor asking that the channel may be properly drained. A copy of my report on the case sent to the Collector with this office

No. 2293, dated 21st June 1906, is appended for information. I would strongly recommend my proposals being carried out, but the question of funds requires settling.

Serial No.	NAME OF BASIN.	Area.	AREA.			VENTAGE		
			Already properly drained.	Being drained.	To be drained.	Existing in 1900.	Being supplied since 1900.	Required.
1	Manikhati	16	...	...	16	...	...	80
2	Charrial	37	37	...	...	200	...	...
3	Kaurapukur	28	...	...	28	...	...	140
4	Roypore	22	...	...	22	...	...	110
5	Godakhali	19	...	...	19	40	...	55
6	Telari	5	5	...	...	40	...	...
7	Katkhali	28	...	...	28	...	...	140
8	Borool	5	5	...	...	20	...	...
9	Ahmedpore	5	5	...	...	40	...	...
10	Kaurapukur	2½	2½	...	...	40	...	...
11	Falta	18	...	...	18	...	...	90
12	Nainan	3	...	...	3	...	...	15
13	Birasi	3	3	...	...	30	...	...
14	Nila	6	...	...	6	...	...	30
15	Kholakhali	11	11	...	...	30	...	...
16	Diamond Harbour	219	...	219	...	...	1,200	...
17	Hara (new)	24	...	...	24	...	...	120
18	Hara (existing)	5	5	...	...	36	...	...
19	Kulpi	28	28	...	...	120	...	...
20	Tangrabichi	17	17	...	...	120	...	...
21	Chitamari	1½	1½	...	...	24	...	...
22	Jhinkra	8	...	...	8	...	...	40
23	Tetulia	3½	3½	...	...	20	...	...
24	Dhutkhali	8	...	8	...	...	...	...
25	Satpukur	43	43	...	...	225	...	...
26	Khari	31	...	...	31	81	...	74
27	Foolbagicha	1	...	1	...	...	6½	...
28	Mohamaya	5	...	...	5	...	...	25
29	Sadeal	4	4	...	...	25	...	...
30	Patnighata	4	4	...	...	81	...	...
31	Habka	50	...	50	...	..	240	...
32	Tilpi	1	1	...	...	2	...	...
33	Dhosa	1	1	...	...	7	...	...
34	Surjeepore	25	...	25	...	...	300	...
35	Utterbhag	5	5	...	...	18	...	...
36	Haral	0½	0½	...	...	2½	...	...
37	Roypore	2	2	...	...	22	...	...
38	Saugore	0½	0½	...	...	2½	...	...
39	Samukpota	2½	2½	...	...	15	...	...
40	Arapanch	30	...	30	...	...	200	...
41	Daragichi	0½	0½	...	...	21	...	...
42	Dehi	2	...	...	2	...	...	10
43	Panchpota	3	3	...	...	25	...	...
44	Srikistopore	3½	3½	...	...	19	...	...
45	Tangraberia	5½	5½	...	...	37	...	...
46	Goredoho	2½	...	...	2½	...	...	12
47	Nirimassa	1	...	...	1	...	...	5
48	Jalaraut	5	...	...	5	...	...	25
49	Kalaboro	1¾	1¼	...	...	12	...	...
50	Nishantolla	5	5	...	...	30	...	...
	Total ...	757¼	205¾	333	218½	1,385	1,946½	971

C. ADDAMS-WILLIAMS,

Executive Engineer,

Northern Drainage and Embankment Division.

No. 2293, dated the 21st June 1906.

From—The Executive Engineer, Northern Drainage and Embankment Division,

To—The Collector, 24-Parganas, Alipore.

WITH reference to your No. M$\frac{419}{3}$, of 1906, dated the 5th instant, forwarding a copy of a letter No. 6, dated the 21st April last, from the Chairman of the Baruipur Municipality with a memorial, in original, addressed to His Honour the Lieutenant-Governor of Bengal, praying for the excavation of the Moraganga Channel, I have the honour to return the petition, and to report that the excavation of the Moraganga Channel, also known as the Ganga Nadi, has not been included in the Magra Hât Drainage Scheme, as its excavation is not necessary for the drainage of the area included in the scheme.

2. I enclose an index map showing the channel and the boundary of the Magra Hât Drainage area. From this it will be seen that the channel starting from near Garia passes south-eastward and runs parallel with the Garia-Baruipore road crossing the Eastern Bengal State Railway about a mile to the south of Baruipore Railway Station. Continuing in a south-easterly direction, more or less parallel to the Baruipore-Surjeepore road, it ends at Surjeepore, the total length being about 15 or 16 miles. The channel at the northern end for about 5 miles is outside the Magra area, and for the rest of the way forms the north-eastern boundary of the area to be drained by the scheme. The latter portion passes through comparatively high ground, and the general slope of the country is to the south. For this reason, the area to the south of the channel will be drained by the Hotar khal, which passes through the heart of the main swamp in the portion of the area to be drained. The Hotar khal falls into the Moraganga Channel about 2 miles to the north-west of Surjeepur, and this portion will be excavated under the scheme to form an outfall for the Hotar khal.

3. At Surjeepore a sluice of 6 vents has been in existence for some years, but under the Magra Hât Scheme the sluice has been transferred to the mouth of the Surjeepur khal at Utterbhag, and the old sluice at Surjeepur is now being partially dismantled and converted into a bridge. Any improvement to the Moraganga channel can be connected up with this portion of the scheme as there will be a comparatively small increase in the discharge, which will not diminish the efficiency of the new sluice at Utterbhag.

4. I have not inspected the whole of the Moraganga channel, but those portions which I have seen consist of pools of stagnant water, which remain throughout the cold and hot weathers. The channel is an old river bed, and it appears that most of the pools have been formed by excavating the bed, for raising land on the banks.

5. To improve the channel I would recommend excavating a channel along the centre of the bed, utilizing the earth excavated in filling up the pools as far as possible. The channel should be graded for the southern portion, from a point near Baruipore to Garia, a small sluice being constructed on the south bank of Tolly's Nala. The channel has not been surveyed by this Department ; until some levels have been taken, it is not possible to frame an estimate of the cost of these works.

6. The improvement of the channel will be recommended to the Committee of Enquiry appointed under Municipal Department's resolution No. 1379 (Medical) of the 26th March 1906, to enquire into the causes of malaria, &c., in the Presidency Division. I do not think the cost of improving the channel can be charged against the Magra Hât Scheme as no provision has been made in the estimates, but if approved of by Government it might be carried out from the savings of the scheme, if any, but it is too early to say whether any savings will be made.

B. S. Press—20-2-1907—11193—350—E. J. H.

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